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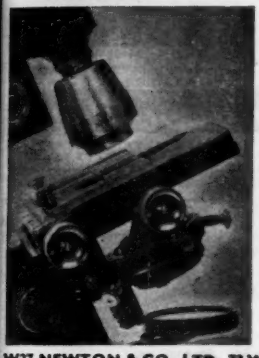

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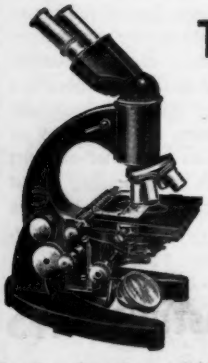

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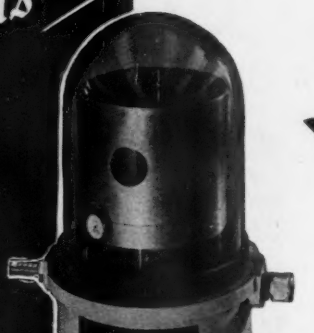

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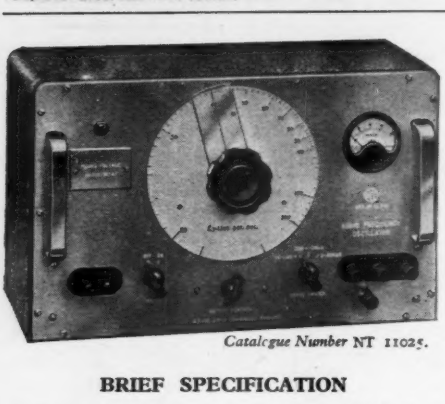

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SCIENCE, TECHNOLOGY AND INDUSTRY

THE report of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research for the year 1950–51, a survey of which appears elsewhere in this issue of *Nature* (p. 946), is marked by a note of anxiety which has not been found in these reports for many years. At the outset, the Advisory Council refers to its grave concern about the delay in giving full effect to the Department's post-war plans. The plans submitted to the Privy Council in 1945 for the expansion of the Department of Scientific and Industrial Research to meet the post-war needs as the Advisory Council then saw them, were formulated to strengthen the economic and industrial position of Great Britain in the face of a quickening tempo of scientific and technological advance and sharper competition in the world's markets. It is plain that the Advisory Council did not over-estimate these needs, and in general the basis on which its plans were laid has been substantiated by most, if not all, the reports of the 'productivity teams' of the Anglo-American Productivity Council and of the 'working parties' of the Board of Trade.

These plans, which were given general approval by the Government, provided for the development of the Department's existing establishments and the creation of three new ones, the growth of the industrial research associations and additional grants for the training of many more research workers and for fundamental research at the universities. The emphasis placed on the need for increased productivity in the face of recurrent economic crises has accentuated the importance of such steps, and virtually the only serious criticism has been of the balance or distribution of the nation's research effort—whether available resources in material and in scientific and technical man-power will be most effectively utilized in the way proposed or in some other balance between industry, the universities and government establishments. The question of the relative efficiency of research associations as compared with the research establishments of private firms or with other means for co-operative research has sometimes been raised, but the need for expansion has not been challenged. In the present report the Advisory Council refers in some detail to the way in which difficulties in recruitment and in building have seriously hampered the realization of its plans. These difficulties have now been gravely accentuated by the needs of rearmament. Rearmament must have priority; but effective rearmament, like our whole economic future, depends on a highly efficient industry, and the Advisory Council urges that special and immediate steps should be taken to remove the obstacles to the development of the Department's plans at an adequate pace.

The post-war plans of the Department called for an increase of scientific and administrative staff from 2,160 in 1946 to about 4,000. The present total is about 3,000, and after allowing for some transfers

not contemplated in the post-war plans, the net recruitment over the period has averaged 150 a year. During the past two years, this has fallen to only 110, and the Advisory Council insists that a level of at least 150 is essential, despite the increased demands of the Services and the defence research establishments.

This figure appears to be reasonable, though without further analysis its relation to the present output of some 8,000 graduates in science and technology from the universities each year cannot be judged, if indeed the assumption is made that none of the 9,000 graduates in arts is recruited and that the Department is not seeking to recruit some senior and experienced scientists and technologists in addition to young men leaving the universities and colleges of technology. Moreover, if the research associations, or some of them, are to any extent to supply the smaller firms with the trained and experienced technologists they need, the figure may well be too low to allow for movement or transfer of staff on an adequate scale.

This quantitative aspect merits a little closer examination than could be given to it in the Advisory Council's report, but there appears to be a prima facie case for the figure recommended. No reasons are given in the report to account for the difficulty experienced in obtaining the desired number of recruits: it is not suggested that the conditions of service or salaries offered are unattractive or inadequate; and there appears no reason to suppose that secrecy requirements or security regulations play any significant part. But the situation disclosed by the Advisory Council's report is sufficiently serious to warrant some further inquiry into both the quantitative and the qualitative aspects. The fifth annual report of the Advisory Council on Scientific Policy (Cmd. 8561. London: H.M.S.O., 6*d*.) which has just been issued as a White Paper, deals with the latter part of this problem. The question of staff, however, appears to be subsidiary to that of the building programme, in which progress has been extremely disappointing. At to-day's prices the cost of the Department's building programme would be of the order of £10 million, and the way in which year by year expenditure has fallen behind schedule has already, through rising prices, added to the magnitude of the task. Moreover, when at length it seemed possible that the rate of expenditure could be raised to the agreed level of £1 million per annum, a severe cut was imposed and the Advisory Council doubts whether expenditure for 1951–52 will reach £500,000.

Nor are the difficulties solely in finance and materials. Great difficulty has been experienced in securing new sites for stations and in obtaining land for extensions, mainly in obtaining the consent of the numerous central and local authorities concerned. The Advisory Council expresses full appreciation of the efforts of the Ministry of Works to meet the Department's requirements; but the cumulative effect of these and other details is to create a situation of extreme difficulty for the Department, with serious consequences for the national interest.

The new Mechanical Engineering Research Laboratory, which the Department is under an obligation to develop as the chief national centre for basic research in all branches of mechanical engineering, will serve industries which are responsible in the aggregate for exports valued at more than £744,000,000 a year and also play a most important part in rearmament. The total cost is put at some £2 million, and the Advisory Council regards maintenance of annual expenditure at a level of £250,000 as essential until the building of the new laboratory is complete. Every effort should also be made to complete the new Hydraulics Research Station, for which a site has been secured at Wallingford. At present Britain has no national centre for basic research and experiments with models on such problems as those of coastal erosion and accretion; the effect of dredging or drainage schemes on estuaries and rivers; and the design of dock and harbour works so as to avoid silting. The absence of such facilities has led both to recourse to foreign institutions and to the loss of important contracts.

Accommodation for research on the treatment of water, sewage and trade effluents, which is essential from the point of health and the conservation of water resources, apart from the growing economic importance of recovery of valuable products from waste waters, is already quite inadequate, but the contract for the new station at Stevenage has been deferred for a year on Government direction. A new road research laboratory is required to accommodate the post-war programme of the Road Research Board; and although satisfactory progress has been made in the reconstruction and extension of the Building Research Station, much remains to be done before responsibility for sociological and economic research can be transferred from the Ministry of Works to the Department and the resulting economies can be achieved. The accommodation for the work of the Radio Research Board is also quite inadequate, and the post-war programme of this Board also urgently demands the erection of a properly designed research station. Finally, Great Britain, which builds one-third of the world's shipping, lacks an up-to-date 'tank' and ancillary equipment for studying the design of ships' hulls and propellers. The obsolescent 'tanks' at the National Physical Laboratory cannot meet the industry's needs for tests—for which it pays—and construction of a modern 'tank' at an estimated cost of £2 million is imperative.

Besides these most urgent examples, the Advisory Council has clearly been at considerable pains, both in its own report and in the accompanying summaries of work, to demonstrate the vital relation of the Department's work to the national welfare and its industrial progress, as well as to supply an account of its activities which is the proper counterpart to the measure of financial autonomy which the Department has hitherto enjoyed. It is, indeed, difficult to suggest what more the Advisory Council could do in this matter. The necessity for rigid scrutiny of expenditure on civil research is recognized and accepted as reasonable; but with equal firmness and

reason it urges that some flexibility is imperative in the estimates of such a Department, and the effective planning of research must be based on reasonably firm budgetary expectations for several years ahead. It cannot be undertaken efficiently on a year-to-year basis, and the report provides sufficient illustrations of ways in which sudden changes in the Department's budget threaten both short-term and long-term national interests.

The expenditure of the Department and its post-war plans for development have, of course, to be scrutinized in the light of the financial situation disclosed in Mr. R. A. Butler's Budget statement and in the subsequent White Paper "Economic Survey for 1952". They have also to be examined in relation to the general world pattern of scientific and technological development. The full cost of the Department's post-war plans has risen from the estimate of £4 million per annum, approved in 1946, to some £7½ million; and the Advisory Council is convinced that no attempt should be made to hold the Department's expenditure at any given level, such as that for the current year. This report shows that it is most seriously concerned that the Government seems to show little appreciation of the consequences of delaying or abandoning what the Advisory Council firmly believes to be essential developments in the scientific and technical resources of Great Britain.

Grounds for such doubts as to whether the Government has a considered policy for science and technology can be discerned outside the report. The whole trend of the Budget statement in regard to the capital re-equipment of industry and to obsolescence generally is not reassuring from the point of view of technological progress; nor are doubts as to whether the present taxation policy is such as to encourage industrial enterprise and development dispelled by such political factiousness as has deprived the country of the services, as chairman of the Royal Commission on Taxation, of one who is outstandingly qualified by experience and commanded the confidence of independent opinion in his impartiality, and who could also have been relied upon to see that the bearing of taxation policy upon scientific development was not overlooked. Nor in other matters into which scientific and technical factors enter—such as higher technological education, national parks or Nature reserves—has the present Government inspired greater confidence than its immediate predecessor in its decision, courage and honesty.

The Advisory Council's report is first and foremost a challenge to the Government to produce a policy. It is equally a challenge to scientific and technological opinion. In the light of the information on the work of the Department now available in its annual reports and those of the various boards and research associations, as well as in other departmental publications listed in an appendix to the present report, vague generalizations about the work of the Department are not sufficient. If it is held that the work is inefficient or misdirected, that there is waste of effort or overlapping with what is being done elsewhere, or that quicker or bigger returns on the national effort could be obtained by other means, it is a clear duty for the scientific worker, technologist or industrialist to specify exactly where the weakness lies, and to give a reasoned statement for his opinion. To acquiesce in what is honestly believed to be inefficient or wasteful would be a clear dereliction of public duty.

If informed criticism is the first requirement, the second need is that the work of the Department should be considered in relation to the work which is being done in the universities as well as in industry. The Advisory Council itself recognizes that there are ways in which its work is closely related to that of the universities and may affect the universities' own plans for expansion or development. It is not simply a matter of the Department being in competition with the universities themselves for trained scientific workers and technologists. The Department is concerned much more positively with the problem of increasing the number of technologically trained people in industry—in research, production or in positions of authority and control—and ensuring an adequate supply of scientific men for the country generally, as well as for industry and government departments. In present circumstances, the Advisory Council believes quite rightly that science graduates should not be encouraged to remain at the universities unless they show special promise as research workers. Equally, it believes that it is in the national interest to provide means by which men with special gifts for research should have the opportunity of receiving their early research training under scientific leaders in the universities.

To strike a precise balance between these two considerations in terms of numbers of men or of finance is scarcely possible. In recent years the Advisory Council has provided annually about four hundred new maintenance awards for postgraduate training in research, if candidates with the requisite qualifications present themselves, and on the advice of its Scientific Grants Committee it proposes to continue to plan on this basis. In view of the increasing necessity for giving full weight to economic factors in planning applied research programmes, and the consequent need in industry for men who combine a knowledge of economics, and sometimes sociology, with technology, the allowances will in future be available to honours graduates in pure or applied science who wish to take up the investigation of problems of productivity and industrial organization in their more economic or sociological aspects.

These awards of the Department of Scientific and Industrial Research represent the principal means for research training in fields within the Department's scope; and although there are other means by which graduates can obtain training in research at universities, it is obvious that this aspect of the Department's activities requires consideration, both in relation to the needs and organization of the country for fundamental research, and to the general plans for university development or consolidation during the next five years. In the absence of facilities at its own research stations, the Department is also carrying out some of its own investigations in the departments

of different universities, and supporting a number of special investigations at universities. This in itself must sometimes raise the question of balance of departments or studies at particular universities; but it can also raise the question of resources, of both men and materials. For example, one of the two projects for the development of research into radio astronomy which the Department is supporting at the Universities of Manchester and Cambridge, and which the Advisory Council regards as essential to the maintenance of Great Britain's lead in this comparatively new field, involves not only a large cost but also a considerable quantity of steel. By implication, the decision to proceed in this matter lies outside the competence of the Advisory Council. It is equally clear that the decision whether or not to allocate the necessary finance and steel should be taken at a level high enough and competent enough to assess the significance of the project from the technical and scientific point of view, not merely from a purely financial or economic one. It can only be wisely made, in fact, if the Government has a clear policy for scientific and technological development.

The present report of the Department thus appears at a moment when it may be appropriate for scientific men and technologists to press anew the necessity for having such a policy as was advocated in a series of reports towards the end of the Second World War, and the great dangers of snap decisions. The over-riding necessity for the utmost economy of the nation's limited resources is not disputed, and the way in which the work and expenditure of the Department of Scientific and Industrial Research are linked with those of the universities of Great Britain should stimulate fresh thinking about the means by which full account can be given of the expenditure of these large sums of money, and the strictest control exercised without adversely affecting the efficient conduct of research or the atmosphere in which such creative work is most fruitful. But the crucial question is the allocation of a sufficient proportion of the nation's man-power and resources to scientific and technical research. In these days, when so large a proportion of the nation's income is devoted to social services, there is increasing risk that a drive for economy may concentrate on curtailing the productive activities of the State. It may well be that if the expenditure on scientific and industrial research—in the Department itself, at the universities or in industry—is to be maintained at the level which the needs of defence and the economic future of Great Britain demand, some inroads on the standard of living and the social services, even if only temporary, may be unavoidable. The alternative may well be an infinitely greater deterioration later, or even national bankruptcy or downfall. Those who believe with the Advisory Council that, to make Britain prosperous again, British industry must make science a real and living force in its daily life, should seek by all possible means to bring this warning home to the Government, and press for new courage, vision and decision in matters where science and technology are concerned.

ANALYSIS OF INSTINCTIVE BEHAVIOUR

The Study of Instinct

By N. Tinbergen. Pp. xii+228. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 25*s*. net.

WITHIN the past fifteen years or so, there has been a revival of interest in the problems of animal behaviour, and much new work, both observational and experimental, has been carried out which has added greatly to our knowledge of this intricate subject. The literature has grown considerably; new journals have come into being, the *Zeitschrift für Tierpsychologie* (Berlin) in 1937 and *Behaviour* (Leyden) in 1947. Now Dr. N. Tinbergen, who has himself played a leading part in this revival, together with his Dutch colleagues, has performed a very useful service in making available to English-speaking readers the results of the latest investigations and the new theoretical views that have emerged.

The book includes a good bibliography, and is adequately illustrated. It will be found indispensable by all serious students of animal behaviour, or 'ethology' as the subject is often called now. It is a significant and healthy sign that much of the work here reported has been carried out either in the open air or in laboratory conditions closely approximating to the normal, and that the experiments made are simple and 'natural'. Outstanding examples are the observations of K. Lorenz on birds; Tinbergen's observations on the hunting wasp *Philanthus*, and his analysis of the sexual and reproductive behaviour of the stickleback; and also Baerends's study of the digger wasp *Ammophila* and the behaviour of cichlid fishes. The need for a very full and thorough knowledge of an animal's normal behaviour in the wild is fully recognized, and acted upon.

Tinbergen distinguishes three ways of studying instinctive behaviour. The first is to seek for the 'causal structure' underlying it. This "leads to a study of the functions of the sense-organs, of hormones, of the nervous system, of the muscles, and, particularly, of the co-ordination of these functions, of their integration into the act of behaviour as a whole". The second is to concentrate on the directiveness or biological purposiveness of instinctive action. This is important for an understanding of behaviour, but it is not a substitute for causal study. The third way is the psychological one. This again cannot supply a causal explanation. Tinbergen holds that it is idle either to claim or to deny the existence of subjective experience in animals; but he admits a limited validity to the psychological approach, provided it keeps within its own field. "The study of directiveness, the study of subjective phenomena, and the study of causation are three ways of thinking about behaviour, each of which is consistent in the application of its own methods. However, when they trespass into each other's fields, confusion results" (p. 5). This is a reasonable and undogmatic way of looking at the matter, but it leaves unsolved the intractable problem of the relation between psychological and physiological activity. On this point Tinbergen resigns himself to a duality of thinking (p. 206).

Tinbergen's own interest is primarily in the causal study of behaviour, though he devotes a most interesting chapter to the directiveness or adaptiveness of

behaviour. The major part of his book, Chapters 2–5, deals accordingly with the causal analysis of behaviour. Later chapters discuss the development of behaviour in the individual and the evolution of behaviour. One of the most interesting points which has been established in recent years is that many animals respond not to all the sensory impressions they receive but only to a limited number of rather simple 'sign-stimuli'; experiments show, for example, that the essential stimulus which incites a male stickleback to attack an intruding male is the red colour on the belly of the intruder, and that its other visible characteristics are disregarded. Here arises a fundamental question. Is it sufficient to speak of stimuli, or of stimulation, meaning by that a purely physiological process? Or is there not involved the psychological function of perception, an active selective activity, having, no doubt, a physiological basis or background, but different in nature from purely physiological activity? Tinbergen seems to accept the view that each animal has its own perceptual world (p. 16), and he does in practice assume that animals see, hear, smell, taste, and experience tactile sensations. If this be so, then there is here a limit to a purely causal interpretation. We must accept perception as a function of the animal organism, but it can never be explained in purely physiological terms, though its physiological conditions may, of course, be studied with profit. Tinbergen recognizes also that on the executive side instinctive behaviour shows clear signs of striving to attain an end, at least in its first phase of 'appetitive' behaviour. The 'consummatory act' in which it culminates "is relatively simple; at its most complex, it is a chain of reactions, each of which may be a simultaneous combination of a taxis and a fixed pattern. But appetitive behaviour is a true purposive activity, offering all the problems of plasticity, adaptiveness, and of complex integration that baffle the scientist in his study of behaviour as a whole" (p. 106).

It does not seem possible to study behaviour adequately without taking into account such psychological functions as perception and directive striving, and they do not fit in to the 'causal structure'. That is the great difficulty which confronts the student of animal behaviour.

E. S. RUSSELL

EXPERIMENTAL PSYCHOLOGY

Handbook of Experimental Psychology

Edited by Prof. S. S. Stevens. (Wiley Publications in Psychology.) Pp. xi+1436. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 120*s*. net.

ON the dust cover of this book the following words appear: "Thirty-four leading scientists contribute nearly one million words to this definitive account . . ." It is perfectly true; and very good words they are. One hesitates to use the hackneyed phrase, 'a storehouse of valuable information', but that is what this book is.

Prof. S. S. Stevens says in his preface that the need for a handbook arises "when the mass of new material in the journals becomes unmanageable". If, as he implies, a 'handbook' is to be regarded as a secondary digest, it would be entirely in the spirit of the book to say that he and his contributing authors have done not a little digesting; it is not that the hydrolysis has been carried very far, but that it has been applied to such a remarkable diversity of material which is so striking. It used to be said that successful animals were mostly those that could eat anything; let the would-be successful biologist try this. The following sample of the subjects treated will indicate how broadly the term 'experimental psychology' has been interpreted: mathematics and measurement, neurophysiology (five chapters), ontogenetic development, neural maturation, genetics of behaviour, growth curves, phylogenetic comparison. These are additional to the conventional or expected contents of a work with this title.

There is much to commend the ideal principle that the psychologist, more than most other scientific workers, should take all knowledge for his province; for all that man does is his business. No single person could even remotely approach such an ideal. But if we apply it rather to psychology as a whole, we have the concept—even now only struggling into the corporate consciousness—of a psychology hungry for ideas from zoology, engineering, mathematics, physics, chemistry and, indeed, from every growing-point of knowledge. If that be a desirable trend, the catholicity of this book is justified.

On the other hand, the wide range of subjects and the attempt—which it seems fair to infer—to break away from tradition and produce something not merely up to date but also in the spirit of the second half of the twentieth century, must have intensified the usual conflict between perfectionism and impatience to publish. It is no disparagement to say that impatience has won on points, for it would probably have taken several years longer, allowing for the continual writing-in of new material, to distil the pure essence from each chapter and minimize redundancy. It could well be argued that such labour would be superfluous in a work which is by nature ephemeral; and it could be answered that much of the material here is not ephemeral. A few of the basic anatomical and physiological facts of interest to a psychologist may turn out, in the next ten years, to be not facts at all—but very few; likewise, formulæ and their pictorial analogues—whether graphs or flow diagrams of servo-mechanisms—may lose their specific applicability; but, as demonstrations of principles, they do not age. It is in these respects particularly that one feels that a closer liaison between the contributors would have reduced the supererogation and disjointedness of the book. It is surely unnecessary, for example, for two contributors to give diagrams of simple idealized servo-mechanisms, together with families of exponential and damped oscillatory response curves.

Probably no single reviewer—certainly not the present one—would be qualified to appraise the accuracy of a book which wanders in so many fields; but it appears to be of a high order, as post-war books go. The derivation of equation (15) on p. 333 is confused, and equation (20) seems to be dimensionally wrong; but as they are scarcely more relevant to psychology than any random selection from a text-book of applied mathematics, no harm is done.

As for omissions, one must protest that kinæsthesis deserves more than the two-thirds of a page given to it in the chapter on somæsthesis. All too little is known about the muscle, tendon and joint receptors; but it is most important that what is known should be stated. Admittedly, by looking up "Matthews" in the index, one can trace most of it in other parts of the book; but not all readers would know this.

Sensory (apart from visual) adaptation is mentioned, almost *en passant*, in several places, but does not seem to be regarded as a phenomenon in its own right—which it surely is. Reaction time also receives scant recognition.

To redress the balance, however, it must be said that the physiological chapters, and especially those on vision and hearing, are outstandingly valuable collections of data, not less for their many excellent illustrations than for the text. The other major section of the book—on learning—runs them a close second. The chapters on speech and language, in which applications of the theory of information are discussed, are exceptionally interesting. A welcome new departure for a work of this kind is a chapter with the title "Engineering Psychology and Equipment Design". The editor, in his delightful opening chapter on "Mathematics, Measurement, and Psychophysics", provides most of the humour; possibly the lively figure of speech, the conversational aside and the dry comment are editorial privileges.

In short, this is a book which every experimental psychologist, whether or not he approves of its physiological and mechanistic—one might almost say engineering—bias, will earnestly desire to possess, as will a great many other people. One can only suggest that they form themselves into syndicates to buy it.

W. E. Hick

MONOGRAPH OF AURORÆ

The Auroræ

By Dr. L. Harang. (International Astrophysics Series, Vol. 1.) Pp. x+166. (London: Chapman and Hall, Ltd., 1951.) 25*s*. net.

RESEARCH on the aurora polaris has proceeded with increasing tempo throughout the present century; each decade has brought solid progress, and some have produced new discoveries of great interest. Popular articles and lectures on the subject always meet a good welcome; but books on it appear very seldom. The opening of the second half of the century now brings an excellent work by Dr. L. Harang, one of the most distinguished of the younger followers of his famous countrymen who have been pioneers in this field—Birkeland, Størmer and Vegard. The last previous book on the aurora, published in Great Britain, seems to have been the English translation of the French work by Angot, in 1896.

The aurora is one of the spectacular wonders of Nature, and it is fitting that this book is very well illustrated—with photographs and diagrams numbering rather more than one a page. They illustrate the aurora itself; the apparatus used for photographing auroræ and their spectra; the technical methods used to determine their height and location from simultaneous photographs from different places; their geographical distribution and the isochasms (lines of equal auroral frequency) around the northern and southern magnetic axis-poles; statistics of their occurrence in time, and its relation to the occurrence of solar and magnetic activity; statistics of their distribution in height (including both ordinary auroræ and the very high sunlit auroræ), and also of their directions in plan (along the auroral arcs and draperies); their spectrum; the electrical theory of the aurora (Birkeland, Størmer, Brüche); the detailed connexion between the geographical distribution of auroræ and that of geomagnetic disturbance; and the accompanying changes in the ionosphere revealed by radio methods.

This list gives a good general idea of the scope of the work, which is addressed to the student and specialist rather than to the general reader. Dr. Harang, who was for several years head of the auroral observatory at Tromsø, speaks with authoritative first-hand knowledge of all the observational aspects of the subject, and has also made varied and valuable interpretative studies of the data.

The improvement of auroral spectrographs in recent years has brought a rich harvest, through the efforts particularly of Vegard, Gartlein and Meinel, and yet it is probably only a foretaste of much more still to come. The theory lags behind; but the theorist gains much from the recent observational proof that in auroral arcs protons enter the atmosphere with speeds of several thousands of kilometres a second.

New workers entering this field of research, and many older ones also, will find great benefit from a thorough and repeated study of the wealth of facts and interpretations so well expounded in this book.

S. Chapman

MICROBIOLOGY FOR THE GENERAL STUDENT

Bacteriology

By Prof. Robert E. Buchanan and Estelle D. Buchanan. Fifth edition. Pp. x+678. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1951.) 45*s*. net.

THIRTEEN years have elapsed since the previous (fourth) edition of this book. During that period there have been great changes in microbiology—that protean discipline which is the real subject of this book. The word 'bacteriology' used as its title does not necessarily indicate that yeasts, moulds, viruses and some pathogenic protozoa, as well as bacteria, are included in its subject-matter. In the new edition, which contains 130 pages more than the previous one, an attempt is made to cope with the new material, new emphases and new orientations which the previous thirteen years have yielded. About forty more pages each have been added to morphology and classification, to physiology and applications, and to pathogenic organisms.

The book first gives the student of elementary microbiology a good general perspective and a rather superficial description of the diverse kinds of micro-organisms which are his objects of study. The general approach is still predominantly classical and biological, though the increased space and a re-arrangement of the sequence of chapters devoted to physiology gives a better balance and better reflexion of some newer trends. After the physiology, various micro-organisms are considered, somewhat briefly, in relation to their socially and economically important roles, constructive or destructive. More attention is paid to what they do than to how they do it.

To devote only twenty-eight pages out of 678 to "Resistance to Disease: Immunology and Serology" seems too little, especially when tighter editing of various rather slight pages elsewhere in the book could have saved space for more solid matter on immunity. On the whole, though, the balance of the book is reasonable, given the diversity of aspects to be treated. There are not many books which attempt

to cover in one volume so large a part of microbiology even at an elementary level. This is a formidable task requiring good judgment and much boldness on the part of those attempting it. The present authors have made their task more difficult because they give no references, either to original literature or to other books, monographs and reviews. Thus there is no opportunity of indicating to the student further reading related to topics which are treated, of necessity, superficially. This lack of references is a distinct defect in what is otherwise a useful elementary text-book in a field where few exist. Surely students should be introduced as early as possible to selected examples of original literature, both for its intrinsic value and as training in appreciation and accuracy of bibliographical reference. Citations of literature for further reading would have greatly enhanced the value of this book and would, moreover, have helped the authors to cope with the multiplicity of topics they mention. B. C. J. G. KNIGHT

APPLIED METEOROLOGY

Climate in Everyday Life

By Dr. C. E. P. Brooks. Pp. 314. (London: Ernest Benn, Ltd., 1950.) 21*s.* net.

THIS book has been written to assist all whose vocation it is to supply human needs, whether the needs are electric power, houses and factories, food or clothing. Sometimes one thus engaged does not know the climatic factors important to his work. When he does know the factors, the text and data in the standard books on climatology will usually not answer his questions directly. Often some complex combination of meteorological elements is concerned, or the data in the books are not in the right form. Such professional people and meteorologists (among whom the author of this book has been prominent) working together have, however, found for many subjects the right questions on climatic factors and given the right answers to the questions. The published results of this collaboration are scattered in a multitude of technical books and periodicals which Dr. C. E. P. Brooks here summarizes in a masterly style.

The book is divided into three parts: living with climate, climate as an enemy, and control of climate. The first part opens with chapters on the broad effects of climate on the general way of life and human energy and on the design of houses and factories, and goes on to a long description of the climates of the world written from the economic point of view. The second part deals with climate in relation to the deterioration of materials under the effects of heat, damp and frost, with atmospheric pollution and with climatic accidents, which covers heavy rains, hail, lightning and strong winds. The packaging of goods for export to the tropics is dealt with in particular detail in this part. The third part begins with a study of the climatic data needed for designing heating, air-conditioning and lighting systems, and for selecting appropriate clothing. It continues with the protection of crops against dry winds and of buildings from lightning and the more difficult and speculative matters of fog dispersal and the inducing of clouds to rain but not hail on the crops. Finally, there is a world-wide set of brief climatic tables and a bibliography of about a hundred and fifty references.

Some aspects of applied meteorology, notably the physiological ones, are more fully covered in other books but, on the whole, as Sir David Brunt has written, this book covers a field not attempted in any other. It should be read by business men and members of the medical, engineering and architectural professions to learn how climatology can help them, and by meteorologists to learn how it has been found possible to use the data available to them to answer the often difficult questions posed to them by professional workers. G. A. BULL

INTRODUCTION TO ALTERNATING CURRENT

School Experiments with Alternating Current

By W. E. Pearce. Pp. xii+153. (London: G. Bell and Sons, Ltd., 1951.) 8*s.*

THIS excellent book contains directions for more than a hundred experiments, most of which can be performed by pupils themselves using simple apparatus and working with voltages of 25 volts or less. The stimulus to publication arose from the installation of low-voltage A.C. supplies in Kent schools, followed by the decision of the London County Council to provide equipment of a similar kind for class use; the experiments themselves embody a long experience of teaching the subject, and show how much can be done by a really enthusiastic teacher convinced of the importance of giving his pupils a real understanding of the many applications of alternating current in daily life. The author, who is senior science master at Dover Grammar School, has written several other valuable books of a more formal and conventional type; the present one is unconventional in that it will give a lead to teachers looking for a method of explaining the matter thoroughly without making it all too difficult for younger pupils.

The earlier part of the book contains a number of simple qualitative experiments on the generation, heating effect and magnetic effect of alternating current, the construction of measuring instruments, and the determination of the supply frequency. The later chapters deal with the properties of A.C. circuits and devices, and here the choice of experiments is exceptionally good. No important fundamental property has been omitted. After a detailed examination of the qualitative behaviour of chokes and capacitors, reactances are measured and their variation with frequency explored. A good example of the author's method is his treatment of the series resonant circuit. The reactance of a choke is adjusted until the circuit current is a maximum; the reactances of capacitor and choke are then measured separately and shown to be nearly equal; finally, the voltages across capacitor and choke are shown to be opposite in phase to one another and many times greater than the supply voltage. All this is presented in a way that the fifteen-year-old pupil can understand, and without any mathematics.

The author is to be congratulated on a book which will serve its purpose admirably. One feels that pupils in the third or fourth year of their grammar school course will work through it with enjoyment, and understand their work as well. Teachers of physics in schools will be grateful indeed for the inspiration it contains. G. R. NOAKES

ELECTRON-MICROSCOPIC EVIDENCE ON THE STRUCTURE OF SPIROCHÆTES

By Dr. J. R. G. BRADFIELD
Cavendish Laboratory, Cambridge
AND
Dr. D. B. CATER
Department of Pathology, Cambridge

FROM the clinical point of view, pathogenic spirochætes have been rather exhaustively studied and all kinds of effective therapies developed. From almost every other point of view, however, the spirochætes are a group which bristles with unsolved problems. Their internal structure, physiology and mode of reproduction are all very poorly understood. One thinks of spirochætes as highly characteristic organisms, quite distinct from the main body of bacteria, yet Dobell[1] pointed out in 1912 that, so far as was then known, not a single clear and absolute distinction could be drawn between spirochætes and other related micro-organisms. The same is true in the latest accounts. Each of the major characters which spirochætes have in common—a flexible, spiral body and corkscrew-like motion—can be matched among various other micro-organisms. However, recent observations, made mainly with dark-ground and electron microscopes, and supplemented with ultra-violet and phase-contrast methods, have revealed a structural character which is common to all the spirochætes examined, but not found elsewhere, thus confirming that spirochætes do, in fact, constitute a distinct group and providing a structural basis for classifying them as such.

Our conclusions are summarized in Fig. 1. All the spirochætes which we have studied possess one or more fibrils wound spirally around their body from end to end, sometimes apparently outside the cell membrane (Fig. 1*b*) and sometimes inside (Fig. 1*c*). The whole structure is reminiscent of a piece of two-strand electric-light flex (Fig. 1*a*), in which strand *A* has become fatter (representing the main core of protoplasm) and strand *B* has become thinner and subdivided (representing the bundle of fibrils). Finally, a sheath (representing the cell membrane) has been added, either around *A* alone (Fig. 1*b*) or around both *A* and *B* (Fig. 1*c*). When spirochætes die, or are killed by fixatives, they usually straighten (Fig. 1*e*), so that the fibre-bundle is stretched into the form of the thread on a screw; but they sometimes coil into an even tighter helix than in life (Fig. 1*d*), the fibre-bundle in this case shortening to resemble the centre-post of a spiral staircase. We have taken many electron micrographs showing the various structural components in all these possible relative positions; but it is possible here to reproduce only a few typical micrographs of the three main genera studied—*Leptospira*, *Treponema* and *Cristispira*.

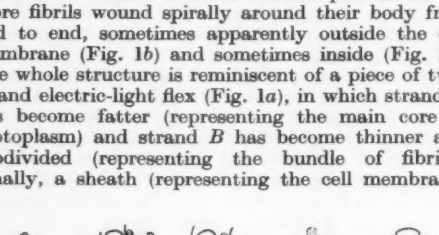

Fig. 1. Diagrams of spirochætes: (*a*) two-strand flex; (*b*) structure of a spirochæte, with protoplasmic core (*A*), spirally wound bundle of fibrils (*B*), and cell-membrane enveloping *A*; (*c*) as (*b*), but with fibril-bundle inside the cell-membrane, as occurs in some spirochætes; (*d*) and (*e*) alternative arrangements of *A* and *B*—in (*d*) the fibril bundle becomes shorter and in (*e*) it becomes longer

The *Leptospiræ* are the thinnest of all spirochætes (0·1–0·2 μ thick and 5–15 μ long). Superimposed on their primary wave pattern (which often can scarcely be resolved by the light microscope) are characteristic secondary flexures which may suddenly increase to such an extent that the opposite ends of one organism coil round each other. Fig. 2*a* shows such a coiled specimen of *Leptospira biflexa*, an easily cultured free-living spirochæte said to inhabit ponds, gutters and dripping taps. The fibril spirally wound around the main core of protoplasm can be most clearly seen at the points marked with arrows. The fibril is particularly prominent where it lies approximately at right angles to the direction of metal shadowing; where it lies parallel, or in unshadowed specimens, the fibril is much less conspicuous owing to its low intrinsic scattering-power, relative to the body as a whole. The appearance of metal-shadowed intact organisms suggests that in *L. biflexa* there is only one of these spirally wound fibrils, and this conclusion is confirmed by study of partly autolysed specimens, where only a single fibril unwinds from an organism as the latter disintegrates. Exactly similar fibrils have been detected in *L. icterohæmorrhagiæ* (of Weil's infective jaundice), *L. canicola* (a pathogen of dogs) and *L. sejroe*.

The *Treponemata* are considerably thicker than the *Leptospiræ*, and consequently intact *Treponemata* are much too dense to reveal details of their internal anatomy in electron microscopes operating at 70 kV., as in our work. However, 'chemical dissection'—in this case, mild trypsin digestion—soon reveals the spirally wound fibrils which exist in this genus. Fig. 2*b* shows a slightly digested *Treponema duttoni* (of African tick-fever) in which the three main components shown diagrammatically in Fig. 1*c* can be distinguished: (1) the cell membrane, which has swollen away from (2) the main protoplasmic core, around which is wound (3) the bundle of fibrils. The result of slightly longer digestion on *T. recurrentis* (of relapsing fever) is shown in Fig. 2*c*. Here the cell membrane has been completely removed, part of the protoplasmic core has dissolved, and the spiral bundle

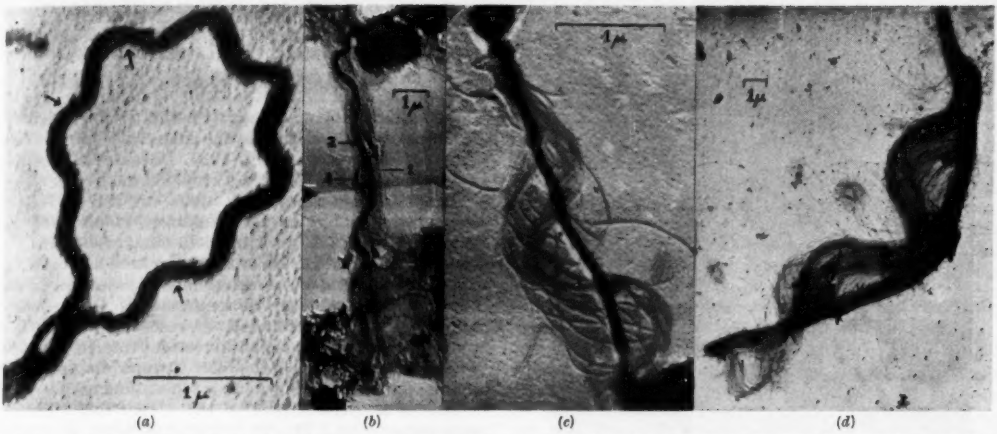

Fig. 2. Electron micrographs of spirochætes: (*a*) *Leptospira biflexa*, a specimen which has coiled into a circle with its spiral fibril prominent where indicated; (*b*) *Treponema duttoni* (after mild trypsin digestion and among remains of mouse erythrocytes) showing three components as in Fig. 1*c*; (*c*) *Treponema recurrentis* (after mild trypsin digestion) showing the spiral fibril bundle disintegrating into its component fibrils; (*d*) *Cristispira balbiani*, a small specimen chosen because its veil-like crista has begun to fall apart, showing the numerous fibrils of which it is composed—the body loses its regular spiral form on fixation. (*a*), (*b*) and (*c*) were shadowed with gold–palladium at approximately 20° to the horizontal

is falling apart into its component fibrils. Eventually the organisms are completely dissolved; but it is interesting to note that, like the fibrillar components of striated muscle fibres, the fibrils of the spirochæte are much more resistant to tryptic digestion than the non-fibrillar components of the protoplasm around them. In both these species of *Treponema* the fibrils are just over 100 A. thick and appear to be inside the cell membrane. In *T. duttoni* there are about eight fibrils in the bundle; in *T. recurrentis* there are fifteen to twenty.

In the remarkable *Cristispira balbiani* from the intestine of the oyster, there are by contrast some hundred or more fibrils (Fig. 2*d*). The veil-like crista, or crest, from which this genus takes its name, is in fact nothing more than a particularly fat spirally wound fibril-bundle—so fat that it is apt to splay out into something very much like the undulating membrane of a trypanosome, with the result that the organism was first named *Trypanosoma balbiani*. The resemblance is, however, quite spurious. Not only are the fibrils in this species much more numerous than those in *Treponemata*, but, again unlike the latter, the fibrils of *Cristispira* appear to be outside the cell membrane for the greater part of their length. In spite of their abundance and extra-cellular location, the fibrils tend to remain closely wrapped around the organism during life, forming only a low crest, and only after death do the fibrils splay out into the broad membranous crista shown in most published accounts.

It has unfortunately been impossible to obtain the large, free-living *Spirochæta plicatilis*, representative of the fourth main genus of spirochætes. Even with the light microscope it is just possible to detect here the sort of structure shown in Fig. 1*d*—the text-books usually describing this organism as a spiral thread of protoplasm 'strengthened' by an axial fibre. Fraulein M. Zuelzer[2], in her extensive researches on spirochætes, predicted that this kind of organization existed also in *Treponema* and *Leptospira*; but the structures involved are well beyond the limit of resolution of the light microscope, and the matter could be properly investigated only when the electron microscope became available.

In contrast to the way in which the basic structure shown in Fig. 1 crops up in all the organisms usually regarded as spirochætes, we have found no trace of spirally wound fibrils in the *Spirilla*, a group of bacteria which closely resemble spirochætes in general form. Instead, a spirillum usually possesses at each end of its body a tuft of free fibrils, commonly called flagella. In our experience, spirochætes, when intact and undamaged by preparative techniques, never possess free fibrils or flagella. Their spirally wound fibrils—whether one, as in *Leptospira*, or more than a hundred, as in *Cristispira*—are always closely wrapped around them; and hence in *Cristispira* and the larger *Treponemata* the fibrils probably form some sort of layer very much like the active sheet suggested by Gray[3], though functioning differently from an active sheet in a rod-shaped bacillus.

That the spiral form of spirochætes and the changes which it can undergo (Fig. 1*d*, *e*) could arise from the kind of organization revealed by the electron micrographs is easily demonstrated by simple models. All that is needed is to endow the fibre-bundle (*B*, Fig. 1*b*) with contractility, and the protoplasmic core (*A*, Fig. 1*b*) with an appropriate degree of elasticity. In the model (Fig. 3*a*) this is achieved by winding a stout elastic band spirally around a piece of rubber tubing which is at first held rigid by a metal rod inside it. The elastic band is wound under moderate tension and securely fastened to the tubing by wire every few inches. If the metal rod is now removed (Fig. 3*b*), the tension in the elastic band (representing the bundle of fibrils) throws the rubber tubing (representing the protoplasmic core) into the form of a spirochæte. The final shape of the helix is that in which the forces resisting deformation in the rubber tube just balance the tension in the elastic band. Fig. 3*a* corresponds to the spirochæte in Fig. 1*e*, and Fig. 3*b* corresponds to Fig. 1*b*.

Whether the fibrils are, in fact, contractile, or merely serve as stiffeners, is at present uncertain, though the balance of evidence is in favour of their being contractile. The very flexible nature of the isolated fibrils argues against their having a skeletal function. Indirect evidence that they are contractile comes from a study of the behaviour of *Cristispira*

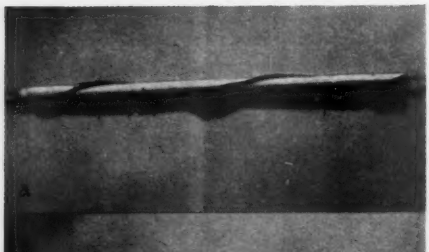

Fig. 3. Models of spirochætes: (*a*) a black elastic band fixed spirally and under tension around a white rubber tube, which is held rigid by a metal rod threaded through it; (*b*) the same after the metal rod has been removed, so that the elastic band is allowed to contract. In both (*a*) and (*b*) the model is lighted from the side; the shadows show that it lies flat in (*a*), but stands up in an irregular spiral in (*b*)

fibrils during tryptic digestion. Instead of dissolving homogeneously, the fibrils break down into strings of beads. What is of particular interest is that the distance between adjacent beads, although fairly constant along any one fibril, varies considerably from one fibril to another. This is so like what is found in the fine structure of striated muscle fibres—where the inter-bead distance appears to vary with the state of contraction of the muscle—as to suggest that the bundle of fibrils of the spirochæte is similarly contractile, and hence that it acts like the elastic band in our models to confer on the spirochæte its spiral form.

However, it would be unwise to elaborate this aspect without further study. For the present, we wish only to establish the existence of these systems of spirally wound fibrils, which seem to be unique structural devices found in all the spirochætes studied here—but only in them—and which thus serve to define the group as a whole and to distinguish it clearly from all related micro-organisms.

We are indebted to Dr. W. E. Kershaw, of the Liverpool School of Tropical Medicine, Dr. J. S. N. Boyd, of the Wellcome Laboratories of Tropical Medicine, London, and Dr. R. M. Fry, of the Public Health Laboratory, Cambridge, for supplying us with organisms; to Prof. J. S. Mitchell for the use of his ultra-violet equipment, and to Prof. J. Gray for stimulating our interest in spirochætes. We hope to describe this work more fully elsewhere and to discuss there its relevance to the many previous studies in this field.

Since this article was submitted, we have found that spirally wound fibrils of the kind observed in all the spirochætes mentioned above exist also in the syphilis parasite, *Treponema pallidum* (the cultured, pathogenic, Nichols strain, kindly supplied by Dr. C. W. Chacko, of the Wright–Fleming Institute).

[1] Dobell, C., *Arch. Protistenkunde*, **26**, 117 (1912).

[2] Zuelzer, M., in Prowazek's "Handb. d. path. Protozoen", **3**, 1628 (1923); see also Noguchi, H., in Jordan and Falk's "Newer Knowledge of Bacteriology and Immunology" (1928).

[3] Gray, J., *Nature*, **168**, 929 (1951).

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT

THE thirty-sixth report of the Department of Scientific and Industrial Research* covers the year ended September 30, 1951. Besides the report of the Committee of the Privy Council over Lord Woolton's signature, and that of the Advisory Council signed by Sir Ian Heilbron, it includes the usual summary of work carried out by the various research stations and boards and research associations. Appendixes, besides the usual lists of assessors to the Advisory Council and of members of the research boards of the Department, of research associations and of grants for special investigations in progress during the year, include once more a classified list of departmental publications issued during the year.

The gross expenditure of the Department for the year ended March 31, 1951, was £5,007,822, as against £4,346,580 in the previous year; but this was reduced by receipts from various sources to £4,554,422, the net increase on 1949–50 being £640,640. The total staff of all grades employed in the Department on October 1, 1951, was 4,088 (including 150 part-time), an increase of 172 over the previous year, compared with increases of 455 and 758 in 1949–50 and 1948–49, respectively. The increase includes 39 members of the staff of the Technical Information and Documents Unit transferred from the Board of Trade on April 1, 1951. The largest single item of net expenditure was the annual grants to research associations, totalling £1,156,358, besides special grants of £270,959. Gross expenditure on the National Physical Laboratory was £726,978, reduced by receipts to £468,848 net. Grants for special researches amounted to £387,902, an increase of £43,492, and grants to students to £236,712 net, an increase of £24,657. Net expenditure on building research was £491,521, an increase of £236,188, but otherwise net expenditures of £243,982 on road research, of £200,931 on fuel research, £176,809 on food investigation, £107,566 on mechanical engineering, £96,986 on forest products research, £47,013 on water pollution, £43,617 on pest infestation, £25,998 on hydraulics and £19,977 on fire research were of the same order as during 1949–50, though that on food investigation was down by £8,597 and that on mechanical engineering was up by £54,900. Expenditure on radio research decreased sharply, by £36,079, to £29,606 net. Of the gross expenditure of £117,117 on the Chemical Research Laboratory and of £44,352 on fire research, £42,934 and £24,375, respectively, was covered by receipts. Net expenditure on the Geological Survey and Museum was £158,201, on headquarters administration £103,483, on headquarters intelligence £48,756 and on headquarters overseas liaison £57,266. Research contracts amounted to £70,606 net, compared with £139,134 in 1949–50.

The number of students-in-training was 910, compared with 828 in 1949–50, and of these 382 were new. The number of senior research awards, of which three were new, was ten compared with sixteen in 1949–50, and fifty new grants for special investigations, brought the total of such grants to ninety-five compared with ninety-three in 1949–50. The pre-

* Department of Scientific and Industrial Research. Report for the Year 1950–51. (Cmd. 8494.) Pp. 271. (London: H.M. Stationery Office, 1952.) 7*s.* 6*d.* net.

ponderance in chemistry and physics continued: of senior research awards, three were in chemistry, six in physics and one in biology; and of the grants for special investigations, 27 were in chemistry, 41 in physics and 13 in engineering. Of the grants to students, 366 were in chemistry, 283 in physics, 68 in biology, 66 in engineering, 58 in mathematics and astronomy, 36 in geology and mineralogy and 33 in metallurgy.

The most important feature of this year's report of the Advisory Council is the note of anxiety which it displays concerning the future of the Department. The reasons for this anxiety and the implications of this situation are discussed elsewhere (p. 937), and here it can only be noted that the Advisory Council's report, like the more detailed summary of work, shows clearly how large a contribution the work of the Department continues to make to the national welfare. In visiting the Road Research Laboratory during the year, for example, the Advisory Council was impressed with the way in which work on road safety is taking definite shape, and quantitative results are accruing on which the responsible authorities can base decisions of policy with confidence. The Laboratory's recommendations for successful bituminous surface dressings are now widely known, while during the year reconstruction of a road at Six Hills in Leicestershire has been utilized for full-scale experiments on the prevention of the irregularity in surface finish of concrete roads laid by machinery. Other investigations have been concerned with the present level of the resistance to skidding, when wet, of the roads of three counties and the traffic capacity of roads, and have revealed the dangers of the present position regarding rear lights.

A visit to the Pest Infestation Laboratory convinced the Advisory Council both of its efficiency and the satisfactory nature of the collaboration with the Infestation Control Division of the Ministry of Agriculture. Largely through this collaboration, the condition of grain in bulk stores at the ports has improved very considerably compared with what it was twelve years ago. This Laboratory, in which a balance has now been struck between research designed to solve practical problems and work of a more fundamental nature, is now devoting more attention to the study of 'domestic' insects, such as flies, carpet beetles and clothes moths. A long-range study of the physical conditions that limit the development of clothes moths, and the application of radioactive tracer techniques to a study of the reaction of fumigants and insects with foodstuffs is already yielding results of immediate practical importance.

The intimate contact and good working conditions of the Food Investigation Organization with the Ministry of Food and, in particular, with the Chief Scientist's Division, have similarly proved invaluable in securing the practical application of scientific results. In this connexion the Advisory Council stresses the importance of the opening of the Ministry's experimental factory at Aberdeen, adjacent to the Torry Research Station, where full-scale processing of foodstuffs will be carried out and it will be possible to study the effects of experimental changes. The Food Investigation Organization will carry out research in connexion with processing at the factory, and a new research vessel, fitted with diesel-electric drive, has been ordered, which will enable the Torry Research Station to work on fish immediately after being caught on the distant fishing grounds, and will also provide fish of known history in sufficient quantities for use in the experimental factory. Other food investigations noted in the report have been concerned with the evaluation and mitigation of certain defects in frozen beef, the curing of ham and bacon, the handling and stowage of fish on board Arctic trawlers, the chemistry of wood smoke and of the constituents of fruits, and the storage of fruit and vegetables; and, besides the further application of ion-exchange chromatography to the analysis of complex mixtures, the more basic research has included the construction of an apparatus for the continuous measurement and the automatic recording of the rate of respiration of vegetable tissues.

The doubling of the expenditure on building research may lend special interest to the account of that work. A formula has been developed which is expected to permit production of a sound cement, meeting the requirements of the British Standard, from the phosphate-bearing limestone found in some of the Colonial territories, and studies in the design of structures have already pointed to substantial savings in the steel used in beams. Work on heating has been dominated for some years by the problem of the small house, and the most important single conclusion reached during the year was that a fair balance of economy and comfort is generally to be found in using a continuous-burning solid fuel fireplace and back-boiler supplying domestic hot-water and two downstairs radiators, together with the use of draught seals on front and rear doors and adequate thermal insulation. The work on building operations and development has continued mainly on the study of productivity and costs of building, the mechanization of building processes and operations and the study of new methods of construction.

Good progress was made during the year in the construction of the permanent building at the Chemical Research Laboratory for radiochemical research. The work of the Laboratory during the year has, however, already been noted in *Nature* (**169**, 67; 1952). An analysis of fires in post-war houses has indicated a significant increase since 1946 in the total annual rate of fires in temporary buildings; and a special analysis of fires caused by sparks from locomotives indicates that a peak period of fire-incidence tends to follow a fall in relative humidity below 48 per cent, and that this will only be ended by the precipitation of a total rainfall of 6 mm. within three consecutive days. Other fire investigations have been concerned with the initiation and growth of fires, the spread of fire between buildings, the use of water-sprays for fire extinction, and industrial hazards such as the ignition of mixtures of inflammable gases and air by sparks caused by striking rusty iron surfaces coated with aluminium paint.

In the Forest Products Research Laboratory, the main work on wood structure has been directed towards the efficient use of the country's timber supplies and the identification and provision of information on new timbers. The seasoning properties of fifteen species of exotic timber were determined during the year, and studies on the abrasion of timber, the durability of plywood, the mechanics of veneer peeling, the penetration of wood preservatives and on sawing problems continued. Co-operation in fuel research within the Commonwealth was strengthened during the year by implementation of some of the recommendations of the Commonwealth Conference on Fuel Research of July 1950. Fundamental

studies on the constitution of coal continued and also on the carbonization, in a setting of intermittent vertical chambers, of Durham coals and of blends of Durham and Northumberland coals to determine the possibility of conserving the limited resources of first-grade coking coals for the production of metallurgical coke. The Fischer–Tropsch process for producing liquid fuels and aliphatic chemicals is being studied with the view of its possible commercial application in Great Britain or elsewhere in the British Commonwealth, while work is also continuing on the elimination of smoke from industrial boilers and on the reduction of external deposits on the heating surfaces of industrial boilers.

The Geological Survey and Museum records only a relatively slow advance towards the completion of a primary six inches to one mile survey of the whole country; but some investigations were made into sources of sulphur in anhydrite and pyrites, and a volume on the "Northampton Sand Ironstone" was issued during the year. A primary well survey of England and Wales, started in 1940, is almost complete. Considerable progress has been made with the development of the new Hydraulics Research Station at Howbery Park, Wallingford. Investigations have continued into the provision of a weir in the River Eden and also the tidal studies in the Wyre estuary at Fleetwood and on the best position for the tide generator in a model of the Thames estuary. The Mechanical Engineering Research Organization expanded steadily during the year, and the building of the Hydraulic Machinery Laboratory was started in July 1951. Most of the work on properties of materials and mechanics of solids continued to be carried out in the National Physical Laboratory. Investigations on the swirling flow of water through a nozzle, with particular reference to boundary conditions, have been resumed at the University of Cambridge, and work on lubrication, wear and corrosion continued at Thorntonhall. The work of the Division of Mechanics of Formation and Machine Shaping of Materials has been divided into four main groups: crystal plasticity; plastic properties of materials; mechanics of formation of materials; and mechanics of shaping of materials. The buildings and services of the heat transfer laboratory at East Kilbride are now unlikely to be ready before 1954.

At the National Physical Laboratory, the Ship Division has experienced a steady and consistent demand from shipbuilders for routine tests on ship designs of all types, and work has begun on the detection and stimulation of turbulent flow on model propellers. Although the expenditure on radio research has been reduced by more than half and work on the new Radio Research Station at Slough had not commenced, the routine forecasts of ionospheric conditions throughout the world prepared at Slough, based on observations at the ionospheric observing stations maintained by the Department at Fraserburgh (Scotland), Singapore and the Falkland Islands, serve to guide those responsible for the choice of frequencies for communication circuits and other purposes. Much attention has also been paid to the properties of germanium and other semiconductors used in crystal diodes, triodes and photocells. Demands on the Water Pollution Research Organization by government departments, local authorities and industry are heavy and increasing. Investigations on the treatment of sewage by mechanical and biological filtration have absorbed much effort, and experiments are also in progress to develop a method for determining in the laboratory, with a known degree of accuracy, the toxicity to fish of dissolved substances.

The Advisory Council in its report refers particularly to the work and new terms of grant for the next five-year period of seven research associations. For the Printing, Packaging and Allied Trades Research Association, which is now spending about £52,000 a year, the annual grant will be £12,000 for the next two years, provided £25,000 is received from industry, and above that will increase £100 for £100 from industry up to a maximum of £10,000; for 1953–56 it will be £16,000, conditional on £40,000 from industry with an additional £16,000 on a £100 for £100 basis. The Advisory Council is concerned at the slenderness of the industrial contribution and the small scale of operation of the Association, although convinced that the Association's work can be of great value to the printing industry in solving its intricate problems relating to surface action. Its work is already making considerable progress in the reduction of idle time while 'making ready', in colour printing and the electronic evaluation of colour.

For the British Jute Trade Research Association, which now includes 90 per cent of the producing firms of the industry, an annual grant of £9,000, conditional on £15,000 coming from the industry, is proposed for the next five years; but it is not anticipated that the industry will be able to increase its support much above £17,000, owing to difficulties arising from the political situation in Pakistan and India. The Association is investigating the numerous fibres, mainly lignified bast fibres in the *Hibiscus* family, which may be satisfactory alternatives to jute, and as regards jute itself a better understanding of the structure of the fibre in relation to its chemical and physical properties is leading to improvements in finishing treatments.

For the British Scientific Instrument Research Association, which in view of its special importance to defence has always received exceptional treatment and already includes 112 out of the potential 150 members, the existing terms of grant were to be continued to March 1952, and thereafter varied until in 1956 the annual grant would be £30,000, provided £20,000 was received from the industry, which, in the Advisory Council's opinion, should considerably increase its support. An additional £20,000 is also proposed on the basis of a £100 for every £100 from the industry.

The Research Association of British Paint, Colour and Varnish Manufacturers has already an industrial income of £30,000 and includes 90 per cent of the productive side of the industry. The new annual grant will be £15,000 conditional on the £30,000 being maintained, with a further £100 for each £100 from the industry up to £15,000. The Association has hitherto concentrated on the study of oils and other materials with the object of conserving scarce materials or finding satisfactory substitutes, but is now turning to the study of the pigmentary qualities of materials not hitherto used.

The British Rayon Research Association, which has earned its maximum grant of £70,000 since its formation in 1945, contemplates considerable expansion. The fundamental work will be extended to include studies of those properties of man-made fibres which bear on their behaviour in processing and in use, and on the technical side developments which will increase productivity will receive the main

effort. For the next five years an annual grant of £50,000 is proposed, conditional on £140,000 coming from the industry, with up to a further £40,000 on the usual £100 for £100 basis.

Only in the past two years has the British Baking Industries Research Association, formed in 1946, begun to produce research results; but while its work can have little effect on sales, though to some extent it may reduce costs, work like that on the prevention of staling is of great potential value to the general public. The annual grant recommended for the next five years is £11,000 conditional on £20,000 coming from the industry, with up to a further £8,000 on the cent per cent basis. The recently formed Cutlery Research Council, covering about 95 per cent of the industry, is a promising attempt to re-establish a co-operative research organization in place of the former Cutlery Research Association, which was dissolved in 1931 owing to lack of support. For this an initial annual grant of £3,000, conditional on £4,000 coming from the industry, is recommended for the next three years, and up to a further £3,000 on the usual cent per cent basis.

Brief mention can be made here of the work of the remaining research associations. The British Shoe and Allied Trades Research Association has worked on the science of shoe comfort and the appraisement of materials for shoe production; and the British Ceramic Research Association on the properties of raw materials used in the pottery industry and on refractories for the iron, steel and carbonizing industries and its survey of the properties of the important brick-making clays of Great Britain. Besides its work on domestic heating, the British Coal Utilization Research Association has investigated the effects of coal characteristics on boiler performance, and has brought its work on the production of phthalic anhydride and other organic acids by the fluidized flow of catalytic oxidation of phenanthrene to the stage of industrial development. That of the British Electrical and Allied Industries Research Association bears mainly upon the production of electricity, its economical transmission and distribution, its most efficient utilization and the reliability of equipment; but it has also included fundamental work on dielectrics and on the crystal structure of basic magnetic alloy systems, precipitation alloys and the nature and movement of ferromagnetic domains and their boundaries. The Research Association of British Flour Millers from July 1, 1951, has again been given a grant under the Department of Scientific and Industrial Research after eight years under the general supervision of the Minister of Food; it has continued to test home-grown wheat varieties for milling and baking value, and to work on the structure of wheat endosperm and flow particles. Besides its work on cocoa and chocolate, sugar confectionery, jam, meat, etc., the British Food Manufacturing Industries Research Association has collected and made available much information on food regulations in overseas countries, and has assisted in co-ordinating views on the revision of regulations governing the addition of preservatives and other substances to foods in Great Britain.

The British Hydromechanics Research Association is investigating the reliability of graphical and analogy methods of calculating surge pressures in pipelines and the performance of commercial seals and the fundamental processes involved. The British Iron and Steel Research Association has established the feasibility of treating powdered ore to render it suitable for use in blast furnaces, and a co-operative study indicated the possibility of appreciable economy of fuel and increased output by automatic roof-temperature control in open-hearth furnaces. The Design and Research Centre for the Gold, Silver and Jewellery Industries has developed a new process for giving an attractive lustrous glitter to fancy jewellery and articles by vacuum evaporation of metals such as aluminium, while the British Launderers' Research Association has directed attention to the serious damage to textile fabrics caused by the unskilful use by the general public of proprietary brands of bleach for the removal of stains—damage frequently wrongly attributed to the use of bleach or rough handling in the laundry. During the second quarter of 1951, forty-four firms tested 847 vehicles on the proving ground of the Motor Industry Research Association near Nuneaton. The British Paper and Board Industry Research Association has developed a new pulping process which operates at atmospheric pressure; by this method, whole wheat straw in bales can be utilized either for semi-pulp or for the production of writing paper. An important contribution from the Research Association of British Rubber Manufacturers is on the mechanism of the rapid deterioration of popular single-texture mackintoshes induced by minute traces of copper compounds, and means of preventing it are now being studied.

These examples should sufficiently indicate how varied and important is the contribution which the work of the research associations and indeed of the Department of Scientific and Industrial Research as a whole is making both to industrial efficiency and productivity and to almost every side of national welfare and daily life.

FORTY YEARS OF X-RAY DIFFRACTION

By Prof. J. M. Bijvoet (President), Prof. J. D. Bernal, F.R.S., and Prof. A. L. Patterson
International Union of Crystallography

FORTY years ago, on June 8, 1912, the first account of diffraction experiments of X-rays by crystals, by Friedrich, Knipping and von Laue, was published in the *Sitzungsberichte der Bayerischen Akademie der Wissenschaften*. This event, among the most important discoveries of twentieth-century science, is being commemorated this year by the International Union of Crystallography; and the X-Ray Analysis Group of the Institute of Physics, at the instance of the British National Committee for Crystallography, is arranging a special meeting to be held at the Royal Institution during October 24–25, at which it is hoped that Prof. M. von Laue and Sir Lawrence Bragg will speak.

The experimental verification of von Laue's ingenious idea of three-dimensional diffraction substantiated at the same time the wave character of X-rays, then in dispute, and the reality of the abstract and mathematical lattice theory of crystals. The result was to open two new fields of science, namely, that of X-ray spectroscopy, which with Moseley's work was to provide decisive support to the quantum theory of the atom, and that of crystal structure determination, destined to have an even greater importance to chemistry.

For the first time the real arrangement of the individual atoms in simple compounds was brought to light by the analyses of W. H. and W. L. Bragg, which, like von Laue's inspiration, were recognized with the award of the Nobel prize in 1915 and 1914 respectively.

The first effect of the X-ray analysis in inorganic chemistry was to create a new structural theory in which the hitherto mysterious chemical affinity of atoms was replaced by the simple physical attraction between charged ions. Inorganic stereochemistry was born and was developed with the determination of the spatial configurations of compounds of continually increasing complexity, making possible the explanation of their physical and chemical behaviour from their chemical composition and atomic properties. Thus, the chemistry of the silicates and other mineral groups was clarified and there appeared, for the first time, an explanation of the composition of alloys, laying the foundation of the new chemistry and physics of the metallic state.

The methods of organic chemistry itself had been adequate to deduce the spatial models of molecules. However, not only were their concepts proved *ad oculos*, but also more detailed and important information was obtained by direct measurement of the molecules with the X-ray wave-length as the measuring unit. In some cases, X-ray analysis even went ahead of the chemical approach, for example, in the race after the structure of penicillin. At present an exciting attack is being made on the structure of the proteins.

Von Laue's contribution to X-ray diffraction concerns the physical foundation of X-ray scattering. The latter may be treated in two ways, either by neglecting the mutual influence of the particles in their scattering of the incident beam, or by taking it into account. The first case—the common scattering by a mosaic crystal—has been treated by von Laue in his famous early papers; the second—scattering by ideal crystal—in a very elegant way in 1930. The latter was developed on a somewhat different footing—scattering dipoles at the lattice points instead of scattering by continuous electron distribution—in fundamental papers by Ewald (1916). Mention should be made of the early thorough investigation of both cases by Darwin (1914).

A number of essential difficulties, even after the conception of three-dimensional wave diffraction, remained to be unravelled*. A single point may be mentioned.

In the first paper it is stated: "Unentschieden bleibe vorläufig, ob die periodische Strahlung erst im Kristall durch Fluoreszenz entsteht oder ob sie neben den Impulsen schon in der primären Strahlung vorhanden ist und durch den Kristall nur ausgesondert wird". In the next paper: "sodass die photographische Platte vollständig geschwärzt werden müsste, wenn nicht die Eigenschaften der Gitter-*elemente* eine bestimmte endliche Zahl aus den unendlich vielen Wellenlängen der ursprünglichen Strahlung aussonderten". It is now known that the latter reasoning was invalidated by the restriction of the beam to a minimum wave-length. The true solution was reached soon afterwards in a rush of X-ray investigation in many countries, which followed the reports of von Laue's discovery. W. L. Bragg showed that a crystal plane gives continuous reflexion of incident white radiation. This eliminated a restriction of the scattering to wave-lengths characteristic of the scattering particles, from which supposition the initial choice of the rather unfavourable copper sulphate as diffracting crystal in the experiments of Friedrich, Knipping and von Laue originated. The diffraction by the lattice of real fluorescent radiation excited in the crystal has been realized later on in the so-called Kossel lines (1935), and it has been studied extensively by von Laue in his dynamical theory of scattering.

A point of view adhered to in the first few papers was that of the conditions of diffraction being fulfilled approximately by the spots on the diagram for some characteristic wave-lengths. They turned out to be fulfilled *exactly* for a *series* of different wave-lengths. Those developments are worth remembering; they increase still further our admiration for the way of solving problems, the difficulties of which in the light of our present knowledge might escape due recognition. These problems remained after the theory of wave diffraction by the three-dimensional grating had been worked out. The diffraction directions were formulated in the well-known von Laue conditions and all essential details of X-ray diffraction were the decline of scattering power because of atomic dimensions and heat motion. One finds every result in von Laue's first paper.

The supporters of the corpuscular theory of X-rays soon afterwards had to accept its wave character. The remarkably modern way in which Sir William Bragg expressed the situation, not deciding between the two theories but retaining them both, should be quoted: "The problem remains to discover how two hypotheses so different in appearance can be so closely linked together".

Immediately after von Laue's first paper, Stark proposed a test of the corpuscular theory of X-rays by imitating their diffraction by that of an electron beam. If, as Stark supposed, X-ray diffraction were to be caused by particles running through the channels of the crystal, electrons too should give such diffraction results. One wonders how the situation would have developed if electron diffraction had been detected at this early stage!

Another point may be mentioned when reviewing these first years of X-ray analysis. As early as 1915, Sir William Bragg pointed out that the periodic electron distribution in the crystal might be developed into a Fourier series, each reflexion indicating one density wave. At that time quantitative application was beyond possibility. Thus the phase problem, as to how to superpose the density waves in order that the atomic distribution of electrons might be found, was not touched. This phase problem, which prevents the direct Fourier synthesis of electron density from the data given by the diffraction spots, constitutes the central problem of X-ray analysis to-day.

The ever-increasing importance of X-ray diffraction in pure and applied science will be the highest reward to the initiators of this domain.

Note from Sir Lawrence Bragg, O.B.E., F.R.S.

At the time that Laue made his great discovery, my father held the view that X-rays had the properties of material particles rather than those of electromagnetic waves like light. As regards the effects he was studying, he was justified; he had

* A valuable reprint of von Laue's first papers is given in Ostwald's Klassiker der exacten Wissenschaften ("Die Interferenz der Röntgenstrahlung", Akad. Verlagsges. Leipzig, 1923); a vivid description of this first period in Prof. K. Lonsdale's "Crystals and X-rays" (G. Bell and Sons, Ltd., London, 1948).

deduced quite correctly that the X-rays in passing through a gas behaved like projectiles, or as we should now say photons, giving a large energy to a few electrons while leaving the remainder untouched.

At that time, I was a young student at Cambridge and was led to study Laue's paper because it seemed to contradict my father's theories. I came to the conclusion that Laue's effects were indeed due to diffraction; but that it was the diffraction of a continuous spectrum rather than one composed of specific wave-lengths as Laue had supposed. The seeming irregularities which led Laue to his postulate, I ascribed to the arrangement of the atoms in the crystal, and was thus led to my first contributions, the idea of the reflexion of X-rays and the atomic arrangement in sodium chloride. My father seized on the reflexion idea to build the first X-ray spectrometer, and with it he established that the diffracted waves had all the properties of X-rays, thus removing any last doubt about their nature.

But the X-ray spectrometer also led to two new things: a much more powerful way of analysing crystals, and the establishment of X-ray spectra. Moseley is justly famous for discovering the succession of the elements, but it was my father who founded X-ray spectroscopy and first established the existence of relations between the spectra of successive elements in the Periodic Table. Moseley's great generalization was foreshadowed by my father's measurement of the K and L spectra for some dozen elements with the X-ray spectrometer. At this stage I had the opportunity of working with my father at the University of Leeds, and the structures of quite a range of simple crystals were determined by using the spectrometer.

OBITUARIES

Prof. P. Dienes

Prof. Paul Dienes, who died on March 23, was born at Tokay in Hungary in 1882, where his father, Barna Dienes, a jurist, owned vineyards. His mother, Ilona Pusztay, was of Greek origin. Apart from two visits to Paris, where he made close contacts with Borel and Hadamard, he remained at Budapest as student and lecturer until 1919. During the Government of Bela Khun he took an active part in educational projects, especially in relation to the University, and was obliged to leave the country when this Government fell in 1919.

It was about this time that W. H. Young was attempting to carry out, at Aberystwyth, the reform of the university teaching of mathematics, and Dienes was one of the Continental mathematicians who were invited to help. Valiron was then giving his well-known lectures on the theory of integral functions. Dienes left Aberystwyth on Young's resignation to go to Swansea, where he remained until he went to Birkbeck College, London, in 1929. He was at Birkbeck College as reader and later as professor until his retirement in 1948.

While he was in Budapest his main interest in mathematics was in the theory of functions of a complex variable. After he came to Britain, he did not return to this subject except to write his book on the Taylor series. He was at this time very much attracted to relativity theory, and for a number of years his researches were in this and differential geometry. This was later changed for infinite matrices and logic, although his interest in logic went back to 1917.

Dienes was a mathematician essentially of the Paris school, and he has done much to promote good relations between French and British mathematicians. Immediately after the liberation of France, he instituted a seminar at Birkbeck College at which many French mathematicians have given courses. They include Mandelbrojt, L. Schwarz, Dieudonné and H. Cartan, to mention only a few.

His was a most charming personality and he was greatly loved by both his colleagues and his students. He would spend a great deal of time and patience on the fundamental concepts of analysis, and he had the facility of making the subject live. His interests ranged far outside mathematics. He had a deep love of music; his taste was for the classical and modern composers and he had little liking for the romantics. A brilliant conversationalist, he told many thrilling and entertaining versions of his escape from Hungary and of his various activities in the first few months of his exile.

In the last few years of his life he became deeply interested in the mystical aspects of Eastern as well as Christian philosophy and religion. He published through the Fortune Press a cycle of poems in this vein with the title "The Maiden and the Unicorn".

A. C. Offord

Mr. J. L. Peters

Ornithology has suffered a grievous loss by the death of Mr. J. L. Peters on April 19 after a short illness.

James Lee Peters was born in Boston on August 13, 1889, and from an early age was interested in natural history. While at Harvard University he came to know Dr. Thomas Barbour and Outram Bangs, of the Museum of Comparative Zoology. The latter was an outstanding figure in ornithology at that time, and no doubt he encouraged young Peters's interest in birds. After graduating in 1912, Peters went on a collecting expedition to Quintana Roo, Mexico, and other trips followed to islands in the West Indies. During 1920–21 he spent some time in the Argentine collecting on behalf of Dr. J. C. Phillips, and on his return was made associate in ornithology under Bangs; for the next dozen years he worked in close co-operation with that ornithologist, finally succeeding him as curator of birds in the Museum of Comparative Zoology in 1933. After he became assistant curator in 1927, he went on a short collecting trip to the Corn Islands in the Caribbean Sea, and in the following year visited Honduras. In 1933 he visited Britain to attend the International Congress at Oxford, at which he read a paper on the "Generic Limits of some Fruit Pigeons".

After the Catalogue of Birds in the British Museum was finished in 1895, Bowdler Sharpe began to prepare a "Handlist of the Genera and Species of Birds" which was completed in 1909. This was a very useful work; but it had become quite out of date. A new list was badly needed and its preparation appealed to Peters, who was fortunate in obtaining the support of both the Museum and University authorities at Harvard University. The first volume of the Check List of Birds of the World appeared in 1931, and up to date seven volumes have been published—the last, containing the beginning of the Passeriformes, appeared towards the end of 1951.

NEWS and VIEWS

Secretaryship of the Smithsonian Institution: Dr. A. Wetmore

Dr. A. Wetmore, who is retiring from the secretaryship of the Smithsonian Institution, Washington, D.C., started his scientific career in the Kansas Museum. In 1910 he joined the Biological Survey as assistant biologist, and in 1925 was appointed assistant secretary to the United States National Museum—the Smithsonian Institution—becoming secretary nineteen years later. While with the Biological Survey, Dr. Wetmore made important investigations on the food and feeding habits of various water-birds and also did some work on lead poisoning in ducks. He has made a special study of fossil birds of North America—indeed, he is a leading authority—and in 1940 published a check-list of the species described from that part of the world. In 1930 he brought out a classification of birds of the world which he has revised from time to time, and this classification has been adopted by many authors. He is also the author of a number of papers on anatomy and osteology. Dr. Wetmore makes a point of spending part of each year in the field studying and collecting birds which, in spite of his onerous official duties, he has always found time to work out. Outside the United States these trips have included islands in the West Indies, Venezuela, Central America, and several of the South American Republics. During 1926–29 he was president of the American Ornithologists' Union, and in 1950 he presided at the International Ornithological Congress at Uppsala. He is an honorary member of many foreign societies. In addition to his scientific papers, Dr. Wetmore published in 1930 a small work on bird migration, and in 1937 was part author of the National Geographic Society's "Book of Birds".

Dr. L. Carmichael

Dr. Wetmore will be succeeded in January next year by Dr. Leonard Carmichael, who is at present president of Tufts College, Medford and Boston, Mass. Dr. Carmichael graduated in psychology from Tufts College in 1921 and then took his Ph.D. at Harvard University. He later taught at Princeton and Brown Universities, and also at the University of Rochester, where he was dean of the Faculty of Arts and Science and professor of psychology. During the Second World War Dr. Carmichael was director of the National Roster of the Scientific and Specialized Personnel, the agency which listed and mobilized scientific workers in the United States for the war effort; he is at present a member of a number of committees dealing with various aspects of government affairs, and in particular is director of a survey on the impact of Federal policy on the economy of New England, which has been sponsored by the National Planning Association. Dr. Carmichael was elected to the presidency of Tufts College in 1938, and has been active in the expansion and changes that have taken place in the College since that date. Scientific research has received considerable impetus, and, in particular, the medical and dental schools of the College have been considerably expanded. These aspects of Dr. Carmichael's administration reflect his continued personal interest in research work, which is in the field of sensory psychology and physiology. He is a member of the National Academy of Sciences.

Mathematics at Sheffield: Dr. D. G. Northcott

Dr. Douglas Geoffrey Northcott, who succeeds Prof. A. G. Walker in the chair of mathematics in the University of Sheffield (see *Nature*, March 15, p. 444), is outstanding among the younger Cambridge geometers. Born in 1916, he went up from Christ's Hospital to St. John's College, Cambridge, in 1935, with an open scholarship in mathematics, and was a wrangler in 1937, obtaining a distinction in Part III of the Mathematical Tripos in 1938. He then began research in analysis under Prof. G. H. Hardy, showing such promise that he was awarded a Commonwealth Fund fellowship to Princeton in June 1939. Soon after the outbreak of war, however, he enlisted in the Army as a gunner, and was sent to the Far East. He was taken prisoner after the fall of Singapore. In 1946 he returned to Cambridge to continue his mathematical research, and at the beginning of the next academic year he was at length able to take up his Princeton fellowship. While in the United States he was elected to a research fellowship in St. John's College, Cambridge, and soon after his return to England in 1949 he was appointed a University assistant lecturer at Cambridge, becoming a full University lecturer in 1951. His first published paper was on abstract Tauberian theorems; but at Princeton, where he worked under Prof. E. Artin, his interest shifted to modern algebra and its applications to the general problems of algebraic geometry, on which he has written a number of papers, printed in the *Proceedings of the Cambridge Philosophical Society* and elsewhere. The geometry school at Cambridge, under Prof. W. V. D. Hodge, will greatly miss Dr. Northcott's help and inspiration; it will be widely hoped that his new responsibilities will not slacken his mathematical development and achievement, already so distinguished.

Technical Education in Great Britain

The forty-third annual conference of the Association of Technical Institutions was held in London during May 30–June 2. In his presidential address, Mr. H. S. Barlow, of the South-East Technical College and School of Art, discussed the recent Government economies in education and stated that in time these are bound to affect the quality of technical studies in Great Britain; the university and technical college students of the future are the primary and secondary school students of to-day. In discussing higher technological education, on behalf of his Association, Mr. Barlow pressed the Ministry of Education to declare its policy arising out of the White Paper on higher technological education which was issued in September 1951. Mr. Barlow welcomed the recent announcement about the provision of National Certificates in commerce and also directed attention to the reports of the various educational teams which have visited the United States of America under the ægis of the Anglo-American Productivity Council. He believes that the real difficulty in the development of technology in Great Britain lies in the fact that, whereas in the United States most of the best people from the high schools enter industry, most of the best pupils in Britain enter professions. The bias of general education in Britain tends to direct able schoolboys away from employment in industry. "A change of attitude is needed in the schools as

well as among the general public before technology comes to be recognized as the important and highly respected calling which it is on the Continent and in the U.S.A."

South African Fisheries Research Ship *Africana II*

At the present time, when fisheries research and development are receiving so much attention in many parts of the world, it is useful to have available Fisheries Bulletin No. 3 of the South African Fisheries and Marine Biological Survey Division (pp. 47; Pretoria: Government Printer, 1951), in which a clear and concise description is given of a new research ship that has recently gone into service in South Africa. On October 10, 1949, the Fisheries Research Ship *Africana II* was launched from the yard of Messrs. A. and J. Inglis, Ltd., Pointhouse Shipyard, Glasgow. On completion, the vessel sailed from the Clyde on January 28, 1950, and arrived at her home-port of Cape Town on February 22 after an uneventful voyage of twenty-four days with only a brief stop of twenty-four hours at Las Palmas for refuelling. This magnificent vessel of 205 ft. overall length and 1,300 tons displacement is provided with large and well-equipped biological and hydrological laboratories, scientific stores, refrigeration space, net store and scientific workshop. The deck equipment and research methods are substantially similar to those of the British Oceanographical Institute's *Discovery II* and the Ministry of Agriculture and Fisheries' *Ernest Holt*. For shallow water soundings a Marconi 'Visagraph' echo-sounder is fitted, while deep soundings are taken with a Kelvin and Hughes's type *MS* XXI echo-sounder. Marconi 'Radiolocator' radar and Marconi 'Lodestone' direction-finder equipment are installed. F.R.S. *Africana II* is a worthy successor to R.S. *Africana*, which did yeoman service in South African waters for nine years before the Second World War and then spent five years on war service with the South African naval forces. With such a well-designed and well-equipped research ship at their disposal, the staff of the Fisheries and Marine Survey Division of the Department of Commerce and Industries of South Africa should be able to investigate with ever-increasing success the many fisheries and other biological problems that confront them in South African and adjacent waters.

Recent Advances in Sound Recording

Progress in the field of sound recording was amply demonstrated in the annual exhibition of the British Sound Recording Association, held at the Waldorf Hotel, London, during May 17–18. This year, twenty-five exhibitors showed and demonstrated their latest equipment. The reliability of the general run of commercial sound-recording apparatus can now be taken for granted, and the delays in delivery indicate the healthiness of the industry. Apart from commercial ends, a fool-proof apparatus has many uses in science and education, even if only to record a series of observations to be analysed later at leisure. The present history of sound recording is illustrated by the rapid strides in magnetic tape recording, using a thin dispersed film of oxide on a plastic base, the general idea of which was predicted by Poulsen at the turn of the century but not practically achieved until developed in Germany specially for delaying radio-transmission just before the Second World War. Subsequent improvements both in Great Britain and in the United States have displaced the use of steel wire for anything but the recording of speech, actually developed in the United States for air operations over the Pacific. At long last the traditional wax cylinder for office dictating is being replaced by a plastic belt, which can be folded and sent through the post, as can also a paper disk carrying magnetic material, normally used when clamped on a turntable. In the field of commercial disk records, samples of the narrow-groove slow-speed records, which can play for a long time, have been in hand for some years, apart from talking-books for the blind; before the end of the year, two of the leading companies in this field will be making and distributing such disks. The 'battle of the revs', already in full swing in the United States, will soon be in full force in Britain also. Fortunately, many firms can supply reproducers with all three speeds, 78, 45 and 33⅓ r.p.m., and all that the user has to take care of is the use of a needle with the correct radius of needle-tip.

Prehistory of Karnatak, India

Dr. H. D. Sankalia is well known for his work in India on the early prehistory of Gujarat and the Deccan, and in a paper entitled "Studies in the Prehistory of Karnatak" (*Bull. Deccan College and Research Inst., Poona*, 11; 1950), written in collaboration with B. Subba Rao and R. V. Joshi, he has turned his attention to a region farther to the south, namely, the basin of the River Malaprabhā, a tributary of the River Krishna. A number of sections have been observed, and these have yielded lower palæolithic tools—coups de poing, cleavers and the like—which closely resemble the Stellenbosch industries of South Africa. While the Indian specimens can be matched with South African examples from all the various Stellenbosch stages, it is with Stellenbosch III or V that the similarity is closest. A catalogue of the more important finds is given, and these are well illustrated. Indeed, the great improvement in the drawings over those appearing in some of Dr. Sankalia's former articles is very marked. A map and a section at Taminhal are also given. It is to be hoped that further work will be undertaken in this interesting area.

Science and Film

The International Scientific Film Association was founded in October 1947 at a meeting in Paris attended by representatives of many countries throughout the world. It has since then encouraged the creation of national bodies concerned with scientific cinematography in a number of countries, prepared annotated lists of films, reports and other documents for publication by itself or by Unesco, and held, among other meetings, five valuable annual film conventions, in the form of international scientific film congresses and festivals of scientific films. At present the following countries are members of the Association: Australia, Austria, Belgium, Brazil, Czechoslovakia, France, Great Britain, Italy, Monaco, the Netherlands, Poland, South Africa, Switzerland and Uruguay. The Association has now launched a quarterly periodical, *Science and Film*, which is intended to focus attention on the use of the film in research, in medicine, in industry, in scientific information and education, and in the social sciences; the periodical will also carry details of new films and of those in production as well as bibliographical notes on catalogues, books and research papers. Further

information may be obtained from the Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2.

Guide to H.M. Stationery Office Publications

Under the title "The State as Publisher", S. Horrocks, reference librarian of the Manchester Public Libraries, has prepared a useful librarian's guide to the publications of H.M. Stationery Office. This has been issued as Library Association Pamphlet No. 10 and includes a foreword by H. C. C. Welch, controller of the Stationery Office (pp. 32; 1952. 5*s.*; to members of the Library Association, 3*s.* 6*d.*). Mr. Horrocks gives an analytical survey of Stationery Office publications, including parliamentary and sessional papers, parliamentary debates and non-parliamentary publications; and his pamphlet should both assist in the location and acquisition of such publications and also in their handling, for he includes sections on Stationery Office lists and indexes and on the cataloguing of government publications, with details of an interim code for cataloguing, as well as on the arrangement and preservation of such publications. The practical problems which arise are indicated and some suggestions are made for their solution.

Ciba Foundation: Report for 1951

The second report from the Ciba Foundation for the Promotion of International Co-operation in the Field of Medical and Chemical Research covers the year ended December 31, 1951 (pp. 32; from the Ciba Foundation, 41 Portland Place, London, W.1; 1952). During the year the Foundation arranged three further colloquia on endocrinology (hormonal influences on water metabolism; hormones, psychology and behaviour; and the control of anterior pituitary secretions) and two general symposia—one on isotopes in biochemistry, and one on visceral circulation. The report includes brief accounts of these colloquia, with lists of participants, and particulars of the eight volumes containing the proceedings of the twelve conferences arranged by the Foundation which are being published by Messrs. J. and A. Churchill. The third Ciba Foundation lecture, delivered by Prof. B. A. Houssay on July 3, 1951, dealt with "Sex Hormones in Experimental Diabetes". Appendixes list the books and periodicals available in the library at the end of 1951, and a note on the trust deed setting forth the purpose of the Foundation is included.

Mineral Dressing: Symposium in London

The Institution of Mining and Metallurgy is arranging a symposium on "Mineral Dressing", to be held at the Imperial College of Science and Technology (Royal School of Mines), Prince Consort Road, South Kensington, London, S.W.7, during September 23–25. The purpose of the symposium is to discuss recent advances in the subject, and more than thirty papers are being prepared to form the basis for the discussion, these being grouped under three headings as follows: fundamental concepts and experimental methods; advances in practice at selected plants; and advances in plant design and machine manufacture. The symposium is open to all interested. The fee of £2 (£1 to members of the Institution) includes a copy of the proceedings. Further details can be obtained from the Secretary of the Institution at Salisbury House, Finsbury Circus, London, E.C.2.

Beta- and Gamma-Radioactivity: Conference in Amsterdam

The Netherlands Physical Society, under the auspices of the International Union of Pure and Applied Physics and supported by Unesco, is organizing an international conference on beta- and gamma-radioactivity, to be held in Amsterdam during September 1–6. Introductory lectures will be given by leading authorities on the following subjects: beta-disintegration, allowed and forbidden transitions, and k-capture; gamma-transitions and internal conversion; systematics of beta- and gamma-decay and the shell model; angular and polarization correlations; critical discussion of instruments for beta- and gamma-spectroscopy; energy calibration; measurements on nuclear recoil and detection of the neutrino. Short communications of about fifteen minutes duration may be made at the main sessions and at the sectional meetings, and those intending to make such communications should write to the secretary of the conference, Prof. J. de Boer, Bunsenstraat 98, Amsterdam-O, from whom further information can be obtained.

Nutrition Society: New Officers

The following new appointments have been made in the Nutrition Society: *Treasurer*, Dr. A. J. Amos (Laboratories, Dudden Hill Lane, Willesden, London, N.W.10); *Programmes Secretary*, Dr. R. J. Allen (Monkhouse and Glasscock, Ltd., Snowsfields, London, S.E.1); *Secretary*, Dr. G. H. Bourne (London Hospital Medical College, Turner Street, London, E.1); *Members of Council*, Dr. J. D. Hourihane, Dr. E. C. Owen, Dr. R. Passmore and Dr. H. M. Sinclair. All queries regarding the Society's meetings and symposia should be directed to Dr. Allen.

Announcements

The Lavoisier Medal of the Société Chimique de France has been presented to Prof. F. A. Paneth, professor of chemistry in the University of Durham.

The fourteenth award of the William Bowie Medal of the American Geophysical Union (Committee on Geophysics of the National Research Council) has been made to Prof. Harold Jeffreys, Plumian professor of astronomy and experimental philosophy in the University of Cambridge, for his contributions to geophysics, and in particular for his work on co-operation in geophysical research through the agency of the International Union of Geodesy and Geophysics. The Medal was first awarded in 1939 to the late William Bowie, geodesist and geophysicist, after whom it is named.

The National Research Council of Canada is offering ten postdoctorate fellowships, worth 3,000 dollars a year for two years (3,500 dollars for married men), for scientific research to be undertaken at Canadian universities. In addition to the fellowship stipend, a grant may be made for the purchase of apparatus of up to 2,000 dollars during the first year and 1,000 dollars during the second. Applicants may be of any nationality, but must be less than thirty-five years of age; at least half the fellowships will be awarded to Canadians. Further information can be obtained from the National Research Council, Ottawa 2.

ORIENTATION OF THE POLYPEPTIDE CHAINS IN CRYSTALS OF ACID INSULIN SULPHATE

By Dr. BARBARA W. LOW

University Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University

'AIR-DRIED' single crystals of orthorhombic acid insulin sulphate give sharp, somewhat disoriented, X-ray diffraction patterns which extend to spacings of approximately 7 A. The unit cell has the dimensions $a = 44$ A., $b = 51{\cdot}4$ A., $c = 30{\cdot}4$ A., and contains four molecules of molecular weight approximately 12,000. The space group is $P\ 2_12_12_1$ (not $P\ 2_12_12$ as originally suggested[1]). The intensity distribution of the X-ray reflexions shows marked pseudo-body-centring corresponding to the space group $I\ 2_12_12_1$. The relative intensities of 96 reflexions have been measured and corrected by the usual factors.

The relationship between a real molecular structure and its vector structure has been discussed by Kendrew and Perutz[2]. It can be shown that the simple and gross features of a real structure, such as parallel rods or chains, which are regions of high electron density, will, when favourably oriented, appear as prominent features of high density in the vector structure. The Patterson projection of insulin sulphate on the a-plane shows prominent peaks of high vector density in close-packed array, and separated by troughs of approximately equal depth (Fig. 1a). The distances between the peaks are 13 A. along the b direction and 10 A. along (021). This distribution suggests the 'end-on' projection of rods of high vector density parallel to the a-axis. Neither the b- nor the c-plane projection, however, shows a peak distribution which corresponds to the lateral projection of rods (Fig. 1b and c). The complete three-dimensional Patterson synthesis was therefore computed over $z = 0(1/30) - 1/2$ on XRAC, the analogue computer at Pennsylvania State College, through the kindness of Prof. R. Pepinsky. The outstanding feature of this vector structure is a set of well-defined cylindrical rods of high density parallel to a (Fig. 2). The rods are in close-packed array, as the Patterson projection on the a-plane appeared to indicate.

The vector structure implies that the real unit cell contains rods or chains of high electron density parallel to the a-axis. It seems probable that these are polypeptide chains, folded or coiled in some regular way, which form rod-like structures having a core of high electron density near their centre. Sanger[3] found that the insulin molecule of molecular weight 12,000 consisted of four polypeptide chains linked together by disulphide bridges. It seems reasonable to associate each rod in the vector structure with one of those chains, so that the complete molecule would consist of four close-packed chains arranged at the corners of a parallelogram, unless—as seems unlikely—they are arranged in a single row along b. There are two distinctly different types of vector rods which may correspond to the two chemically different types of chains discovered by Sanger[3]. The vector structure does not lead to the clear identification of the four polypeptide chains which describe a single molecule, and at least two

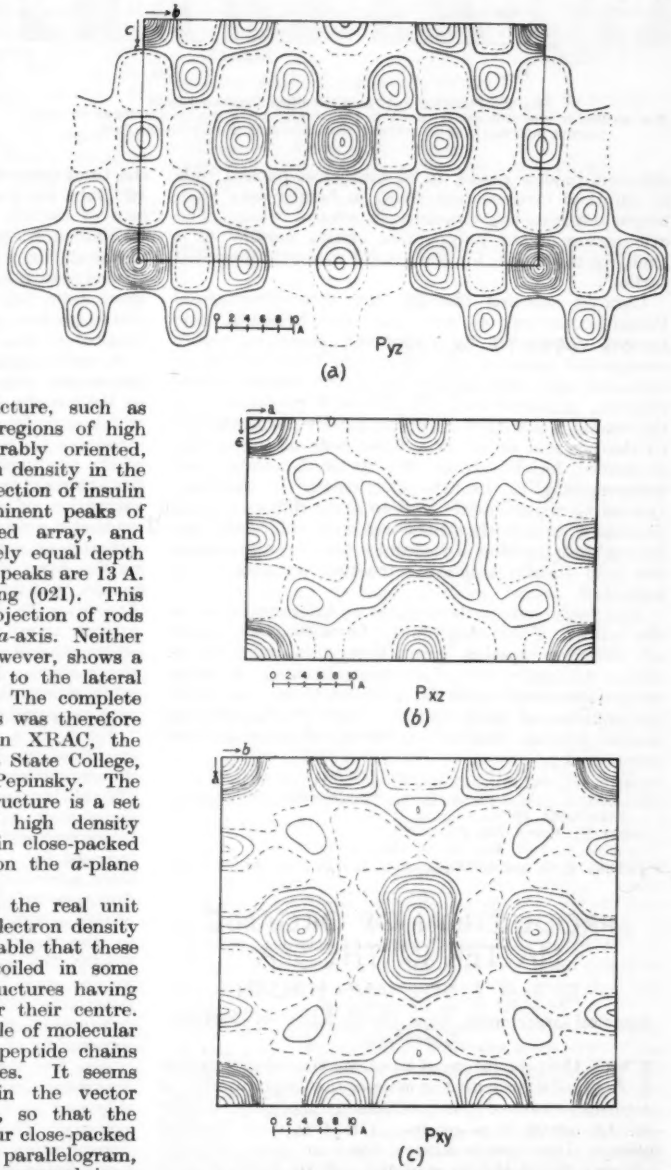

Fig. 1. Patterson projections of 'air-dried' insulin sulphate The outline of the unit cell is shown in each projection. Contours are drawn at equal positive intervals from an arbitrary zero level indicated by broken lines. Some contour lines are omitted in the origin and face-centred peaks

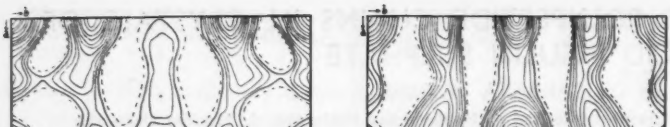

Fig. 2. Patterson sections of 'air-dried' insulin sulphate
The outline of the unit cell is shown in each projection. Contours are drawn at equal positive intervals from an arbitrary zero level indicated by broken lines

different models made up of four close-packed rods of elliptical cross-section 44 A. in height may each be packed into the structure in several ways. The orientation of the polypeptide chains parallel to a excludes the model for the insulin molecule proposed earlier[1].

Limited sections through the three-dimensional Patterson series of 'air-dried' rhombohedral zinc insulin, calculated by Crowfoot[4], show no easily interpreted systems of peaks. On the basis of an infra-red spectroscopic study of the rhombohedral crystals, Ambrose and Elliott[5] have proposed that the chains in insulin run approximately perpendicular to the trigonal axis. The dimensions of the insulin molecule derived from the present study lead independently to the same conclusion. In this case, symmetry requirements lead to three different chain directions in the rhombohedral unit cell; and the lateral close-packing of molecules which is a feature of the acid insulin sulphate structure appears to be excluded.

The Patterson synthesis gives no information about the nature of the chain-fold. Crystals from insulin of different species give X-ray photographs of different distribution of overall intensity. A study of the Patterson series for both 'wet' and 'air-dried' preparations of these crystals is now in progress and should provide information about the more detailed structure.

[1] Low, B. W., Cold Spring Harbor Symposia, **14**, 77 (1949).
[2] Kendrew, J. C., and Perutz, M. F., "Haemoglobin", 101 (London: Butterworth, 1949).
[3] Sanger, F., *Nature*, **163**, 491 (1949).
[4] Crowfoot, D., *Proc. Roy. Soc.*, A, **164**, 580 (1938).
[5] Ambrose, E. J., and Elliott, A., *Proc. Roy. Soc.* A, **208**, 75 (1951).

PRODUCTION OF ORGANIC MATTER IN THE SEA

By Prof. E. STEEMANN NIELSEN
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During the cruise of the Danish oceanographical expedition with the *Galathea*, a large number of determinations of the production of organic matter in the oceans was made. The carbon-14 method already described in *Nature*[1] has been used. A paper giving a full description of the method together with some of the results obtained is now in the press[2].

Although many more investigations, of course, are needed if absolutely reliable figures for the production of organic matter in the oceans are to be obtained, the results of the *Galathea* Expedition are of importance. It is, at any rate, possible now to give the order of magnitude for the production in the sea. As the production there has been much over-estimated, due to the lack hitherto of suitable methods, reliable figures are much needed. In recent years one repeatedly comes across figures according to which the total production of organic matter in the oceans is nearly ten times that of the production on land. These figures originate from Rabinowitch[3], who, on the basis of a paper by Schroeder[4], estimated the total carbon fixation by land plants to be $1{\cdot}9 \times 10^{10}$ tons per year. The corresponding value for the rate of carbon fixation in the oceans according to Rabinowitch is $15{\cdot}5 \times 10^{10}$ tons annually. The material for the estimation of production in the oceans was taken from a table compiled by Riley[5], from which the production of organic matter by the plankton does not change much in going from the equator to the polar circle.

As sessile plants live only on a narrow fringe along the coasts, nearly all production of organic matter in the oceans is due to the Algæ of the plankton, which are found everywhere in the upper water masses of the sea. All material used in this estimate of the production in the open ocean originates either from Seiwell[6] or from Riley[5,7]. Seiwell used the under-saturation of oxygen in the layer below the photosynthetic zone in the south-western part of the North Atlantic as a measure of the production of matter by the Algæ of the plankton. He assumed that this matter was finally oxidized in the layer mentioned. According to Redfield[8], however, the deficiency in oxygen there was established at a time when the water masses were found much farther north and on the surface. The oxygen deficiency thus gives no information about the production of matter in the area in question.

Riley, in a number of investigations, has used a modification of Gran's oxygen method for the determination of the production of organic matter. 250-ml. bottles were filled with surface water in the same way as for routine oxygen tests. During investigations in tropical waters the bottles were exposed for a period of three or seven days. At sea they were suspended in a tub on deck. The long duration of the experiments was used in order to obtain a sufficient effect. As some bottles were kept in the dark and others were illuminated, while, finally, the oxygen in others again was determined at the start of the experiment, it was possible to determine both oxygen consumption and oxygen production, the latter according to Riley being an expression of the photosynthesis.

For five stations in the Sargasso Sea, Riley found an average oxygen consumption of 0·11 mgm./litre per day and an oxygen 'production' of 0·07 mgm./litre per day. The ratio of oxygen 'production' to oxygen consumption was on an average 0·64, a value quite improbable for natural conditions in the sea.

Riley was himself aware that the value for oxygen consumption in the bottles is much greater than in Nature. Whereas a fairly large content of organic

matter in sea water from all depths of the oceans is not attacked by bacteria under natural conditions, it will be attacked as soon as the water is enclosed in bottles, presumably because of the presence of the inner surfaces of the bottles. According to experiments by, for example, Waksman and Renn[8], the oxygen consumption found by Riley is easily explained as being due to respiration of bacteria while the water was in the bottles. The position is different, however, as regards 'oxygen production', that is, the difference in content of oxygen in light and dark bottles. Riley takes it for granted that this difference is due to the photosynthetic activity of the phytoplankton. In all probability it is, however, simply due to the bactericidal effect of the sunlight. It is a well-known fact that sunlight is highly effective for killing bacteria. It is not only the ultra-violet rays which are active; the light not absorbed by glass is also effective. Therefore it is quite natural that the consumption of oxygen in the illuminated bottles should be lower than that in those kept in the dark.

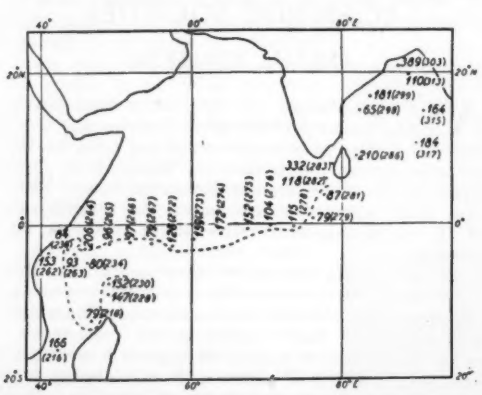
The investigations on the *Galathea* by means of the carbon-14 method give evidence that the order of magnitude for the production of organic matter in Riley's experiments is wrong. Let us compare the Sargasso Sea with the tropical western part of the Indian Ocean, where the amount of plankton at any rate is not smaller than that in the Sargasso Sea. In surface water from six stations (265–274, see chart) the average assimilation of carbon was found to be 0·15 mgm. per hour and cu. m. at 18,000 lux. If the samples, as in the case of Riley's experiments, had been placed in full sunlight during the whole day, we should, according to experience on the *Galathea*, have found a daily assimilation of carbon of $0{\cdot}15 \times 12 \times 0{\cdot}6 = 1{\cdot}08$ mgm. per cu. m. According to Riley, an average of 26 mgm. carbon per cu. m. (corresponding to 0·07 mgm. oxygen/litre) was 'assimilated' daily in the Sargasso Sea. On an average, thus, only 4 per cent of what Riley 'found' in the Sargasso Sea was found in the Indian Ocean.

As an example of the investigations on the *Galathea* Expedition, the production of matter in milligrams of carbon assimilated per day and sq. m. is given for a section across the Indian Ocean in the accompanying chart.

On the basis of all material obtained on the *Galathea* Expedition, an average annual gross production of matter corresponding to 45 gm. assimilated carbon per sq. m. would seem probable. If we reckon on an area of sea of 361×10^6 sq. km., we obtain a total fixation of carbon per year in the sea of $1{\cdot}6 \times 10^{10}$ tons. This is nearly the same as the $1{\cdot}9 \times 10^{10}$ tons carbon which, according to Schroeder, are fixed on land. If, furthermore, we allow for a loss of 25 per cent through respiration, the total net production in the sea per year corresponds to $1{\cdot}2 \times 10^{10}$ tons carbon.

There are considerable variations in the productivity of the different areas of the oceans. The tropical parts are often—but far from always—relatively poor.

[March 17.



Production of organic matter in mg n. per day per sq. m. in the Indian Ocean. Station numbers in brackets

[1] Steemann Nielsen, E., *Nature*, **167**, 684 (1951).
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UNIVERSITY EDUCATION IN DUNDEE

THE Royal Commission on University Education in Dundee, the report of which has now appeared*, was appointed in May 1951, with Lord Tedder as chairman, in view of the failure of Lord Cooper's report, published in August 1949, to lead to any negotiated settlement of the controversy over the organization of university education in Dundee and the relations between the University of St. Andrews and University College, Dundee, which has been going on intermittently for more than sixty years. Although Lord Cooper's suggested solution of the problems involved was not implemented, it was decided that the dispute must be ended by parliamentary settlement, and the Royal Commission was appointed to prescribe in detail the necessary steps to be taken and the changes, if any, which would be required in the constitution, functions and powers of the University of St. Andrews, University College, Dundee, or of any other institution concerned. The situation was altered to some extent by Lord Cooper's report itself, and fresh urgency was given to the problem, both by the concern of the University Grants Committee over the impossibility, under existing conditions, of estimating the expenditure required for the quinquennium commencing in 1952–53, and also by the detrimental effect of continued indecision and hostility on the academic reputation of the University of St. Andrews, and particularly on its departments in Dundee.

The Cooper Report considerably lightened the task of the Royal Commission, and the majority of the Commission's most important conclusions do not seriously conflict with those of Lord Cooper; but the new survey is based on as fully searching an inquiry. For this complex and difficult situation local feelings are responsible as well as the completely different system of government of University College,

* Royal Commission on University Education in Dundee, 1951–52: Report. (Cmd. 8514.) Pp. 75. (London: H.M. Stationery Office, 1952.) 2s. 6d. net.

Dundee, to which the 1889 Act led, from that prescribed by the Act for the University in St. Andrews, and to which the Commission attributes the main responsibility for the controversy and misunderstandings. No real solution, it is held, is possible while this constitutional structure, with its unworkable administrative organization, remains unchanged. Nevertheless, the survey revealed little reason for opinion in Dundee to be dissatisfied with the physical expansion of University College in the past five years, and, following a close analysis of the present situation, which takes full account of the intangible factors, the Commission rejects as firmly as Lord Cooper the proposal for a separate University in Dundee.

The reasoned argument which leads the Royal Commission to reject the idea of separation as neither necessary nor desirable is based on an examination of counter proposals which should at least mollify any disappointment which may be felt. Academic support for the proposal was almost non-existent; but the Commission, pointing out that it is an open question how far the sense of inferiority from which Dundee's local patriotism suffers is a survival from the unhappy past to which both Dundee and St. Andrews cling for different reasons, recognizes that the habit of mind which goes with this feeling is in some ways the most important element in the situation. Nevertheless, the Commission sees no case at all, on grounds of population, geography or communications, for placing a new University in Dundee, within fifteen miles of one University and ninety of three others, all distinguished in tradition and scholarship. Careful examination of the argument based on the industrial needs of Dundee revealed no serious discouragement in the field of applied science, even under the present unsatisfactory organization, while on the grounds of student numbers and the support of fundamental research the Commission is convinced that a new and vigorous academic development which would attract all the support the city can offer is possible within a remodelled University of St. Andrews without risk of discrimination against development in Dundee.

The major part of the report deals with the reorganization of the University to provide one governing body and one supreme authority in academic policy; it also includes a discussion of the changes in teaching policy which would become possible. In the early years of reorganization, it is emphasized that the frank acceptance and faithful implementation of detailed recommendations by an outside body offers the only prospect of agreement on academic policy. It is hoped that prompt government action where legislation is required will be followed by equally prompt and reasonable action in the academic sphere. Points of criticism will no doubt be found in matters of detail. It is not detail, however, but wise and early unification that is important, and the Tedder Report, offering a fair and just solution, provides the opportunity for a new start and for laying aside the dissensions of an unhappy half-century.

Broadly speaking, the type of union recommended is similar to, but rather closer than, that of the Durham and Newcastle Colleges. Subordinated to a single supreme authority, so constituted that it can be trusted to deal fairly with university education in both St. Andrews and Dundee, would be two College Councils, one for the new college in Dundee and one for the United College in St. Andrews. The heads of the two colleges would be designated 'provosts', and the principal of the University, and not the rector, would be chairman of the University Court, which would have the ultimate financial control of the whole University, and he should be provided with official accommodation in Dundee as well as his normal residence in St. Andrews. The Commission expresses the hope that if effect is given to its recommendations, the Queen would be pleased to allow the College in Dundee "to bear a name indicative of Royal favour", and it recommends that all possible steps should be taken to mark by outward and visible signs the new relationship of the University to Dundee and every opportunity taken of showing that Dundee as much as St. Andrews is heir to the traditions and resources of the University. The constitutional position of the Library Committee should be maintained, but with the added responsibility for the development of library facilities in Dundee. A reorientation of the Arts Departments in the new College in Dundee is recommended, and incorporation in the University, as part of the new College in Dundee, of the Dundee School of Economics. Postgraduate work in social sciences should also be developed in Dundee. No formal link between the Dundee Technical College and the University is proposed, and a first responsibility of the new College Council in Dundee would be an examination of the possibilities of development in engineering. The Commission dissents strongly from the view that problems arising from the duplication of teaching in Dundee and St. Andrews can be solved by making a head of department responsible for teaching given in both centres. Here, as in such recommendations as the removal of differences in the standards of admission for students, and of the discouragement by Scottish bursary regulations of those who wish themselves to bear the extra cost of coming from a distance to study in the University of St. Andrews, the Commission is doubtless seeking not only to avoid discords which divided loyalties and irrational disparities can cause, but also to afford the fullest possible opportunity for dissensions to die down and a wiser and more magnanimous spirit to close an unhappy chapter.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

AT the invitation of the Eastbourne Natural History and Archæological Society, the South-Eastern Union of Scientific Societies held its fifty-seventh annual congress at Eastbourne during April 24–27 under the presidency of James Fisher. The local committee was under the chairmanship of T. E. Rodd, with Miss M. A. Ash as local secretary.

At the 'young naturalists' evening' a wide range of questions were answered by a panel of experts and prizes given for the best questions asked. The winning questions were those regarding the persistency of jackdaws in their attempts to acquire a nesting-site and the hatching of robin eggs after being found cold. Colour films were shown of bird life. In his presidential address to the Union, Mr. Fisher dealt with the population and distribution of land birds in

the British Isles, explaining the logarithmic method of plotting counts and the deductions made from the graphs.

The Archæological Section of the Union was addressed by its president, A. Cecil Piper, who discussed "The History of a Downland Village—Alfriston". He traced the development of the village from prehistoric and early historic times, proved by finds of flint and bronze implements, cinerary urns, and British and Roman coins. The Saxons had a considerable settlement, and excavation has brought to light a Saxon cemetery consisting of a hundred and twenty graves. After the Norman Conquest Alfriston came within the rape of Pevensey. Mr. Piper followed the history to the present century, mentioning its importance during the Napoleonic wars and that, at one time, the main occupation of the inhabitants was smuggling. The church was described in detail, and mention made of the Old Clergy House, the first building acquired by the National Trust, in 1896. The president of the Zoological Section, Dr. W. S. Bristowe, spoke on "The Spiders of Islands"; he related his experiences, during collecting, on islands as far apart as the antarctic and the tropics, and explained that, broadly speaking, the number of species diminishes relatively with the area of the islands. In the unavoidable absence of Prof. J. W. Heslop-Harrison, Francis Rose addressed the Botanical Section on "The Vegetation of the Weald", treating his subject from the ecological point of view. The subject of Prof. P. Allen's presidential address to the Geological Section was "Our Chalky Heritage", in which he reviewed the present knowledge of chalk obtained by modern technique, including the electron microscope. He mentioned that the finest chalk in Britain is at Beachy Head, where there is practically no grit or clay and approximately 99 per cent calcium carbonate. At the time of its deposition, the water was salty, clear and more than a hundred fathoms deep, with a warmer climate prevailing than that of the present day.

G. S. Hutchings, warden of Juniper Hall Field Centre, Headley Valley, spoke on "Regional Survey and the S.-E. Union", in which, after discussing the history of the movement within the Union, he outlined proposals for the rejuvenation of the work. Although considerable investigations have been done on the classification of types of plant communities and their distribution, there is in Great Britain no general map of the distribution of types of vegetation. It would be a credit to botanical science, said Mr. Hutchings, if a map could be published showing the distribution of types of vegetation, including a classification worked out, in terms of their ecological status, of lands predominantly in agricultural or industrial use. Two Wealden transect belts were suggested by Mr. Hutchings for survey, because their north–south orientation brings them each within a vertical column of the 2½-in. scale map sheets. One would be from the Thames gravel plain at Molesey via the Mole gap to the coast plain at Worthing. The other runs from the Thames inner estuary at Dartford, through the Central Weald to the South Downs and Cuckmere gap. It may be desirable to produce two distinct maps: one dealing with the physical units, geology, soil, slope, aspect and hydrology; and the other with vegetational, natural and semi-natural plant communities, life communities controlled by man, agricultural land, grazings, planted woodlands, etc.

Some very fine colour 'Kodachrome' slides of local wild-life, prepared and displayed by W. J. C. Murray, were shown by him to members of the Union. The shingle flora and fauna of the Crumbles area was studied by the botanists and ornithologists, who also visited Chailey Common and the Cuckmere Valley from Exceat bridge to the mouth of the river. The archæologists visited the historic and prehistoric sites at Wilmington and Milton Street, the castles and churches at Lewes and Pevensey and the churches at Alfriston and Westham. It is proposed to hold the next congress of the Union in Worthing during May 1953.

THE TEA RESEARCH INSTITUTE OF EAST AFRICA

OPENING CEREMONY

THE Tea Research Institute of East Africa, the foundation and constitution of which were recorded in *Nature* of August 4, 1951, p. 196, was formally opened at Kericho, Kenya, on March 27 by His Excellency Sir Philip Mitchell, chairman of the East Africa High Commission and Governor of Kenya. The company assembled for the occasion included representatives of the tea industry from the three East African territories, government officials and delegates from the Tea Research Institutes in Ceylon and Nyasaland.

The ceremony was presided over by Dr. B. A. Keen, chairman of the governing body and director of the East African Agriculture and Forestry Research Organization. In welcoming the chairman of the High Commission, Dr. Keen briefly recounted the history of the new Institute and paid tribute to the foresight and initiative of the firm of Messrs. Brooke Bond and Co., Ltd., in sponsoring the affairs of the Institute during its formative period, and to the tea boards and associations whose co-operation had made the foundation possible. The Institute, he said, is the first and only research organization in

Tea Research Institute of East Africa, Kericho, Kenya

East Africa to be conceived and established without direct financial support from government sources; it is autonomous and receives its entire funds from the tea industry. Close and friendly liaison has been maintained between the Institute; the East African Advisory Council for Agriculture, Animal Industry and Forestry; the Departments of Agriculture and the East African Agriculture and Forestry Research Organization through the members of the governing body and the director.

In his reply, Sir Philip Mitchell congratulated the tea industry on the inauguration of its own research station, and particularly for having worked on an inter-territorial basis. He traced the growing importance of the tea crop in the economy of East Africa from the early stages at the turn of the nineteenth century when private enterprise in Kenya, and government enterprise at the Botanic Gardens, Entebbe, and the Amani Institute in the then German East Africa, almost simultaneously introduced the first plants of *Camellia sinensis* to reach East Africa. The tea industry reached a commercial basis in 1921, and it is an expanding one. The present is therefore a very opportune time for a commodity research station to begin its work. The combination of science and practice is essential for every progressive industry; and money contributed to the support of the Institute would be in the nature of a well-spent insurance policy.

Dr. T. Eden, director of the Institute, thanked Sir Philip for formally opening the laboratories. The ceremony was followed by an inspection of the laboratories, where demonstrations and exhibits relating to the work of the Institute were on view.

RECENT RESEARCH ON ELECTRICAL CONTACTS

UNDER the auspices of the East Midland Centre of the Institution of Electrical Engineers, a convention on "Electrical Contacts" was held at Loughborough College during April 7–9. The large attendance included members of the electrical, metallurgical and communication industries, of government research establishments and universities, as well as representation from the Netherlands, Belgium, France and Sweden. The convention was opened by Dr. W. G. Radley, engineer-in-chief of the Post Office, who stressed the important part played by contacts in modern communications: for example, in the thirty-year life of a Post Office relay the contact may operate up to 10^9 times; a call between subscribers in the London area may involve 500 contacts; in the British telephone system there are altogether about 3,000 million contacts; and failure in any of these can interrupt or distort the signal.

After Dr. L. B. Hunt (Johnson Matthey and Co., Ltd.) had outlined the requirements that must be fulfilled by a contact material, Dr. A. Fairweather (Post Office Research Station, Dollis Hill) described observations on the behaviour of contacts tarnished by exposure to the atmosphere (sulphide film on silver contacts, and oxide and carbonate film on others); what happens when film-bearing contacts are pressed together; and the properties of sliding contacts at low voltage and low mechanical pressure. A film can be broken either by high pressure or high voltage, so that the resistance of the contact depends entirely on the conditions under which it is measured; for example, a contact may have a resistance of megohms under a voltage of a millivolt, while it may be practically zero under a hundred volts. Dr. Fairweather gave detailed consideration to the change of conductance of a pair of static contacts with time due to progressive tarnishing, and indicated the effects of surface plating. Plating is not always a successful solution of the tarnish problem; for example, a soft plating, such as gold, cannot break a tarnish film on iron–chromium. The rate of corrosion may be increased by a porous plating. Again, if the plating is hard and the substrate soft, the base may sag and the unsupported plating crack under pressure. Contact noise may be due to a moving contact bumping on and off the tract formed through the film on the other contact, and also due to the electrical breakdown of the film, which is usually the important cause; the contact film will be repeatedly broken if, as in practice, the contact is not made at exactly the same place each time. To avoid noise, noble metals must be used. The effect of lubricating the contact with poly-tetrafluoroethylene, which forms a film that remains thin, was also considered.

Dr. A. L. Allen (EricssonTelephones) dealt with long-life contacts for unidirectional currents of 1–20 amp. and indicated the problems found in the use of vibrator contacts. He has measured erosion craters in contact electrodes by using a 'Perspex' replica technique. His conclusion was that the use of bi-metallic contacts is not a promising method of eliminating transfer unless the number of operations is small. Experiments designed to determine contact resistance were then described: tungsten in air is covered with a high-resistance oxide film, as is chromium, but the contact resistance falls when the contacts operate in a rare-gas atmosphere. Dr. Allen concluded that mechanical wear of contacts is insignificant compared with electrical wear; copper-palladium has a low rate of transfer; and the search for new alloys is not a promising solution. He suggested the elimination of transfer by installing parallel circuits to prevent the contact voltage rising above the boiling voltage.

Miss J. Warham (Electrical Research Association) described the effect of inductance on fine transfer between platinum contacts in a 6-V. circuit with currents of the order of 1 amp. and controlled circuit inductance of 0·05–10 μH. Transfer is measured by optical examination of the pips formed on the cathode after a large number (10^5) of operations. The results show that there is a residual transfer at break which is independent of the circuit inductance. This is bridge transfer, which can be explained by the Thomson effect in accordance with Davidson's formula for the shift of the hottest cross-section. Transfer is dependent on inductance when this is greater than 0·3 μH., and this is attributed to a short arc.

Dr. P. M. Davidson (Physics Department, University College of Swansea) outlined the results of calculations which trace in detail the changes in the micro-geometry of the successive stages in the separation of two electrodes. The succession of shapes assumed by a liquid bridge under the action of surface tension includes nodoid shapes and unduloid shapes, of which the cylinder is a particular case. The particular form will depend on the properties of the particular metal (such as the variation of specific resistance with temperature) and how the current changes as the contact potential increases. Slides illustrating the computed results in typical cases were shown. The

influence of the Thomson effect, variation of surface tension with temperature and surface purity, and also the influence of electrodynamic forces were discussed; internal circulating motion in the liquid and modification of the shape of the bridge will be produced. A possible theoretical explanation was proposed for the reported breaking of bridges below the boiling voltage under certain conditions.

The formation and properties of molten metal bridges was discussed by R. H. Jones (Physics Department, University College of Swansea), who analysed the various theories which have been advanced to account for bridge transfer, paying particular attention to temperature distribution in a contact. He described experimental work on the pip and crater formed in a single contact operation, and showed slides illustrating in detail the growth and rupture of the bridge both with single-metal and bi-metallic contacts. Mr. Jones considers that his results can be explained on the basis of the Thomson effect for single-metal contacts and by also taking into account the differing thermal and electrical properties of the metals in a bi-metallic contact.

Prof. F. Llewellyn Jones (Physics Department, University College of Swansea) spoke on the erosion produced by electrical discharges and analysed the basic processes occurring at both the 'make' and the 'break' phases of contact operation. He emphasized the hitherto unsuspected importance of low-voltage discharge phenomena which can occur between electrodes just about to meet ($\sim 10^{-4}$ cm. apart). The problem consists of finding the source and emission mechanisms of the electrons which initiate the discharge and also the means by which the electron current is amplified to produce a discharge avalanche. He reported experiments, carried out with E. T. de la Perrelle and G. G. Morgan, in which the rate of electron emission from cold metal surfaces was investigated by using a pulse technique in which the production of a single electron could be recorded. Comparatively high electron emission from contact surfaces was obtained with electric fields as low as 10^4 V./cm., and the variation of the emission with electric intensity showed that the mechanism was field emission. The emission depended very greatly on the nature of the electrode surface; for example, a thin oxide tarnish layer enhanced the emission at least a thousand times, while the presence of dust (due to the condensation of metal evaporated by the microscopic discharges) could further enhance the emission by a similar factor. Thus the probability of initiation of discharge during the operation of a pair of contacts greatly depends on the surface state of those contacts, and it might be expected that erosion would be greatly increased when those surfaces are dusty or covered with thin tarnish layers. Removal of such layers practically eliminates the discharges and the erosion, while the sweeping of positive ions to the layers greatly enhances the emission.

In distinguishing between two types of films on metal surfaces, namely, tarnish films and grease films, Dr. J. C. Chaston (Johnson Matthey and Co., Ltd.) discussed the tarnishing of copper: in pure air (containing no sulphur) copper, although apparently clean, is covered by an oxide film 85 A. thick which prevents further oxidation. The atmosphere, which both in town and country contains traces of hydrogen sulphide, produces a film of oxide and sulphide on copper about 450 A. thick and reddish-brown in colour; but the thin oxide film, produced in pure air, will protect against the second. Properties of other contact metals were described. He raised a number of questions on the actual area of contact of two apparently plane surfaces, the welding of clean metal surfaces, the continuity or otherwise of the surface film at contact spots, the sticking of contacts, and the passage of current through films 20 A. thick. D. O. Walter (Johnson Matthey and Co., Ltd.) dealt mainly with practical considerations in the design of light-duty sliding contacts, and he also discussed the properties of electrodeposited rhodium. Rhodium ($< 0{\cdot}001$ in.) is often deposited on a silver substrate 0·0005 in. thick, and provides a useful contact surface, but the contact pressure must not be so high as to deform the silver substrate plastically. C. W. A. Mitchell and T. F. A. Urben (Telephone Branch, Post Office Engineering Department) gave an account of the exacting requirements of contact devices in telephone engineering, and discussed the use of various materials under a variety of mechanical conditions. Silver is generally used in low-voltage contacts: a ciné-film showed how contact bounce can be eliminated (or reduced) by proper mechanical design.

These papers were followed by discussion devoted mainly to the influence of tarnish films; from this it may be concluded that light-duty contact operation is greatly determined by the nature of the contact surface, because that surface practically determines a whole train of microphysical phenomena.

The remaining papers related to heavy-duty contacts: Mr. Baxter (Electrical Research Association) reviewed factors causing wear, and Dr. Wilson (General Electric Co., Ltd.) discussed heavy contactors. R. W. Sillars (Metropolitan-Vickers Electrical Co., Ltd.) dealt with arc suppression by associated circuits, T. H. Cook and M. Vaughan (Morgan Crucible Co., Ltd.) with brush contact efficiency, P. F. Soper (Northampton Polytechnic) with sliding contacts, and R. F. Sims (Royal Aircraft Establishment, Farnborough) with brush contacts operating at high altitudes.

F. Llewellyn Jones

SUGGESTED REFORM OF THE INDIAN CALENDAR

At the inaugural meeting of the Indian Astronomical and the Astrophysical Society of India, the president, Prof. M. N. Saha, gave an address on "The Reform of the Indian Calendar", which has recently been published (pp. 26; Indian Science News Association, 92 Upper Circular Road, Calcutta). Prof. Saha commenced by explaining the problems of the calendar and described the different adjustments made by various nations in the past to obviate confusion; but in many cases the adjustments were responsible for raising more problems than they settled. He pointed out that, while the Christian calendar gives the length of the year correctly, it has a number of defects, such as the variation in the length of the months, the fact that the beginning of the month and of the year may fall on any day of the week, resulting in inconvenience to civic and economic activities, the use of the moon for determining certain Christian festivals and holidays, such as Easter, etc., and other inconveniences as well.

Prof. Saha went on to discuss two of the proposals that have been made to reform the Christian calendar

—the thirteen-month calendar and the twelve-month calendar. In the former there would be thirteen months in the year, each of four weeks, a week being, as now, seven days; but in ordinary years the last day would be called 'year-end day', and in leap years there would be an additional 'year-middle day' at the end of July. In the twelve-month calendar, each quarter contains exactly three months—that is, thirteen weeks or ninety-one days—and the quarters begin on Sunday and end on Saturday. The first month in each quarter has thirty-one days and the other two thirty days each. As in the thirteen-month year there would be a 'year-end day' and, in leap years, an additional 'year-middle day'.

A historical sketch was given in the address of the Indian calendars, of which there have been twenty-five different kinds in use. They are divided into three categories: calendars of purely Indian origin; calendars of foreign origin—Christian, Hedjirah Tarikh-Ilahi; and hybrid calendars. Those who are interested in Indian calendars will find a very full description of them, and in an appendix the proposals for a universal calendar are set forth.

Briefly, Prof. Saha suggests that the year should commence on December 22, the winter solstice day, which will always be a Sunday. This new year's day will also be Christmas day, on which various festivals of other nations will be celebrated. The four quarters will each contain ninety-one days, the months of each quarter consisting of thirty-one, thirty and thirty days, and each quarter will start on a Sunday and end on a Saturday. The first, or winter, quarter will end on March 22, which will then be the thirtieth day of the third month, and vernal equinox will be on the previous day. The second, or spring, quarter will start on March 23 and end on June 21, summer solstice day; and the third, or summer, quarter will begin on June 22 and end on September 20, which will be a Saturday. The fourth, or autumn, quarter will commence on Sunday, September 22 (not on September 21, which can be regarded as an extra day and may be called the 'world day'), and the Monday following September 22 is the autumnal equinox. In the case of a leap year, another day can be interposed just before the winter equinox. This proposed calendar, set out fully in the address, with the months numbered 1 to 12 and the names of the corresponding Indian months.

VELOCITY DISTRIBUTION OF SPORADIC METEORS

A PAPER entitled "The Velocity Distribution of Sporadic Meteors", by Mary Almond, J. G. Davies and A. C. B. Lovell[1], has been published which describes the radio-diffraction technique used at Jodrell Bank Experimental Station of the University of Manchester for measuring the velocities of sporadic meteors. While no doubt exists about the elliptical orbits of shower meteors, certain difficulties of technique—particularly in measurements of velocity—have prevented complete agreement on the orbits of sporadic meteors. The observational work of Prentice and Alcock, and Porter's comprehensive analysis of data on meteors, showed that if hyperbolic meteors existed they were extremely rare, and Whipple's photographic methods support this conclusion. Since 1947, radio-echo methods for measuring meteor velocities have been in use, and the technique developed by Davies and Ellyett for the observation of the diffraction pattern produced by meteor trails during their formation has been described[2]. The results confirm that shower meteors have velocities below the parabolic limit. The Jodrell Bank paper gives an account of the work on the velocity distribution of the sporadic meteors.

A full description of the apparatus and method of measurement of velocity is followed in the Jodrell Bank paper by tables giving the results of experiments carried out during the autumn mornings of 1948, using the 4·16-m. equipment and steerable array, and during the autumn mornings of 1949 and the spring evenings of 1950, with the 8·13-m. equipment and fixed array. In the first case, 67 velocities were measured during 230 hours of observation; in the second case, 187 velocity measurements were made during 43·5 hours of observation. In both cases the experiments were concerned with swift meteors emanating from positions in the direction of the apex of the earth's way, and the smooth curves shown in Figs. 1 and 2 of the paper—calculated on the assumption of meteors moving with parabolic velocities and random directions, errors of measurements being superimposed—indicate very close agreement with the observed distribution. The antapex experiments from February 18 until April 29, 1950, observations being carried out between 15h. and 20h., supplied 87 velocities during a total of 213 hours, and a significant difference appeared between the observed and theoretical results. The speeds of the meteors were much smaller than the predicted values, which is attributed to one of two causes or probably to a combination of both. Either the meteors are moving in very elliptical orbits, or their radiants are concentrated towards the plane of the ecliptic; and there is a significant resemblance to the short-period comets, which have elliptical orbits, small inclinations, and nearly always direct motion. In the morning hours the atmosphere is shielded by the earth from meteors with small inclinations and direct motion, but in the early evening hours these can be seen to advantage. In the case of the observations of the meteors during the spring evenings of 1950, it is significant that only one meteor was observed with velocity between 60 and 70 km./sec., whereas in the observations during the morning hours of the previous autumn there were sixty-eight meteors in this range; and it is certain that the high-velocity cut-off in the former case was a real effect. No evidence was obtained from any of the observations that an appreciable number of meteors were moving in hyperbolic orbits.

Estimates of the magnitude-range of the meteors were made by computation of the electron densities in the meteor trails, these densities being converted to visual meteor magnitudes; but the latter does not give very satisfactory results owing to the uncertainty in the theories of the ionization process. It is believed, however, that the major number of measured velocities is around the fifth magnitude. The results show good agreement with those obtained by McKinley and Millman, who used a different radio-echo technique with a different selection of the sporadic meteors. In a later paper the results of the experiments made to cover fainter meteors will be discussed.

[1] *Mon. Not. Roy. Astro. Soc.*, **111**, 6 (1951).
[2] *Nature*, **161**, 596 (1948).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

High-Speed Counting with the Flying Spot Microscope

In the flying spot microscope the specimen is scanned by a single spot and the resulting pictures displayed on a television monitor tube[1]. If the microscope specimen consists of a number of particles, and if the output of the microscope is taken directly to a high-speed counter, each particle will be crossed by the spot more than once, and the counter will register the total number of intercepts, giving a count greater than the number of particles in the field. In order to obtain a count equal to the number of particles in the field, the following development has been made.

A birefringent crystal is mounted between the objective and the specimen, and a 'polarizing cube' below the condenser. An additional photocell is mounted at right-angles to the original photocell. An anti-coincidence circuit is connected between the photocell outputs and the counter. The counter start and stop mechanisms are connected to the microscope frame-blanking amplifier, via differentiating circuits.

Thus the flying spot from the objective is split into two spots by the birefringent crystal, and therefore the specimen is now scanned by two spots instead of one. The spots are adjusted one line-width apart, and are polarized at 90° to one another. The transmitted light from these spots is now collected by the condenser and passed to the photocells via the polarizing cube, which transmits the light from one polarized spot to one photocell and reflects the light from the other polarized spot to the other photocell. Therefore each photocell only receives light from one spot, and never from the other. Consider that the two spots are approaching a microscopic particle, scanning from above, one spot being one line-width above the other. First of all one spot will hit the particle and be obscured. The result is that a signal will be generated by its associated photocell the output of which is, say, positive. This pulse then passes through the anti-coincidence circuit to the counter which then registers one. When this spot returns to the same particle on the next line, it will be one line lower and its companion spot will have taken its former place, one line-width above. The result is that both spots are now obscured by the particle and both photocells generate pulses, which are prevented from operating the counter circuit by the anti-coincidence circuit. Therefore no count is made. This will continue until the time when the bottom spot is off the particle, the top spot being obscured. A signal is now passed by the anti-coincidence circuit to the counter; but as this signal is made negative, it will not operate the counter. Therefore only when the lower spot *alone* is on the particle will the counter operate.

To prevent the counter from repetitive counting of successive frames, it is necessary for it to be started at one end of a frame and switched off at the other end. (This is done by the frame-blanking pulses from the frame-blanking amplifier.) The lagging edge of the frame-blanking pulse is used for operating the start mechanism of the counter, and the leading edge of the succeeding frame pulse to operate the stop mechanisms. It is therefore only necessary to press the reset button of the counter to obtain a complete count of all the particles in the field. Counts of particles at a speed of a million a second have been obtained at accuracies of the order of less than 1 per cent. Multiple-spot operation appears to offer considerable further possibilities in automatic sizing of particles, and this application is now being investigated.

Our thanks are due for technical assistance to D. Causley and G. O. Norrie, and to Mr. Wilfred Taylor, of Cooke, Troughton and Simms, Ltd., for the loan of the 'beam splitting crystal', and to Barr and Stroud, Ltd., for the loan of the 'polarizing cube'. Much stimulation was obtained from a meeting on counting techniques held by the National Coal Board Central Research Establishment[2] on June 12, 1951.

This work has been made possible by grants from the Nuffield Foundation and the Research Division of the British Iron and Steel Federation.

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J. Z. Young

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London, W.C.1. April 30.

[1] Roberts, F., and Young, J. Z., *Nature*, **167**, 231 (1951).
[2] Walton, W. H., *Nature*, **169**, 518 (1952).

Resolving Power in Diffraction Microscopy with Special Reference to X-Rays

Rogers's[1] elementary explanation of Gabor's[2] technique for microscopy treats the hologram as a generalized Fresnel zone plate. I have used this idea for deriving a resolution criterion. Two point objects separated by a distance y produce two Fresnel zone patterns at the hologram with centres separated by a distance z, where $z = p_a y/(p_a - q_a)$, if p_a and q_a are the distances from the illuminating point source of wave-length λ_a to the hologram film and from the film to the object, respectively. The subscript a refers to parameters of the 'analysis' while r will refer to the 'reconstruction'.

If the hologram is enlarged photographically by a factor M, the distance between the centres of the reconstruction patterns, when the hologram is used like a positive lens, is $(p_r + q_r)Mz/p_r$, where p_r and q_r are distances from the illuminating point source of wave-length λ_r to the hologram and from the hologram to the reconstruction, respectively. For resolution in the reconstruction plane, we require that the central maximum of the diffraction pattern due to one object coincide with the first minimum of the diffraction pattern due to the other. According to Myers[3], the angular separation, β, between these two is $\beta = \dfrac{1{\cdot}22\ \lambda}{a}$, where a is the effective aperture of the Fresnel zone pattern being used. These considerations lead to

$$y = \frac{1{\cdot}22\ \lambda_a q_a M}{a_r}\ .$$

Thus, the minimum resolvable distance, y, seems to depend upon the wave-length, λ_a, of the analysis, and the aperture, a_r, of the Fresnel zone pattern used in the reconstruction. So far, the expression does not contradict what the usual lens criterion would lead one to believe.

However, two real factors which limit the aperture of the zone pattern are the resolving power, N, of

the film used in the analysis, and the width, d, of the real illuminating source. I consider two limiting cases.

Case 1. Point source and film of resolving power N cm.$^{-1}$. This leads to a minimum resolvable distance

$$y_1 = \frac{0{\cdot}61\,(m-1)}{mN},$$

where $m = p_r/q_a$, which is independent of the wave-lengths λ_a and λ_r. It predicts good resolution for $m \to 1$ (object close to source) and a reasonable result for $m \to \infty$ ('contact print'). The factor M does not appear.

Case 2. Grainless film and illuminating source of width d cm. This leads to a minimum resolvable distance, $y_2 = 1{\cdot}22d/m$. Again the result is independent of the wave-lengths used. A large m (object close to film) and a small d are indicated. The factor M does not appear. These results proceed from the following inequalities, which are necessary conditions for making a hologram in which the first n central bands are adequately recorded :

$$p_a\lambda_a > \frac{8d(n+1)}{2N}$$

$$m-1 > \frac{8d^2(n+1)}{p_a\lambda_a}, \quad m-1 < \frac{4N^2p_a\lambda_a}{8(n+1)}.$$

For X-rays, where $p = 500$ cm., $\lambda_a = 10^{-8}$ cm., $d = 10^{-3}$ cm., $N = 10^4$ cm.$^{-1}$, $n = 5$, and values of m are dictated by the above inequalities, we get $y_1 = 5{\cdot}53 \times 10^{-5}$ cm. and $y_2 = 2{\cdot}86 \times 10^{-5}$ cm. These would be useful resolvable distances.

The above results and empirical observations on X-ray exposure times seem to indicate that it is feasible to obtain Gabor reconstructions with X-rays. They also point to the possibility of making a Fresnel zone pattern by interference methods with visible light. This zone pattern might be reduced photographically and deposited on an optical flat of beryllium to yield a useful single zone plate for X-rays.

Details of this investigation are being prepared for publication. This work was supported in part by the Research Corporation and the University of Redlands.

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A New After-effect of X-Rays on Dilute Aqueous Suspensions of Bacteriophage

If dilute aqueous suspensions of bacterial virus are exposed to X- or γ-rays, inactivation of the virus continues after the cessation of radiation. After doses of about 15,000 r. to the dysentery phage *S*13, or about 2,000 r. to the coliphage *T*3, the number of phage particles forming plaques is reduced in an hour to less than 10 per cent of the number still surviving at the end of the irradiation. It has been briefly reported[1] that the rate of inactivation after the end of radiation is greater than that found as a result of adding to phage suspensions the amount of hydrogen peroxide which would be produced by the radiation. It has now been established that the greater part of the delayed inactivation of phage after the end of irradiation is due to a change in the phage, occurring during irradiation, which makes it much more susceptible thereafter to the action of added hydrogen peroxide or of the hydrogen peroxide formed by the radiation in the suspending medium.

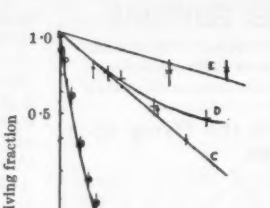

Fig. 1

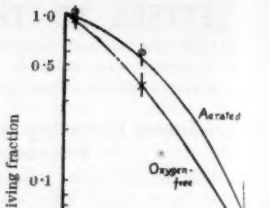

Fig. 2

Fig. 1. Inactivation of phage *S*13 after the end of 15,000 r. of X-rays. (*A*) ○—○—, irradiated phage ; (*B*) ⊗—⊗—, irradiated phage in irradiated buffer ; (*C*) ϕ—ϕ—, non-irradiated phage in irradiated buffer ; (*D*) +—+—, irradiated phage in non-irradiated buffer ; (*E*) ×—×—, control

Fig. 2. Survival of phage *S*13 during irradiation : aerated and oxygen-free suspensions

Fig. 1 illustrates the fraction of surviving phage particles, at various times after the end of irradiation, in the following suspensions of *S*13 : (*A*) a dilute suspension (about 0·8 μgm./ml. total solids) in 10^{-3} *M* phosphate buffer, exposed to 15,000 r. of 200 kV. X-rays ; (*B*) 0·1 ml. of suspension *A* introduced, after irradiation, into 1·9 ml. buffer which had been irradiated simultaneously with *A* ; (*C*) 0·1 ml. of non-irradiated suspension, equal in concentration to *A*, introduced into 1·9 ml. of buffer which had been irradiated simultaneously with *A* ; (*D*) 0·1 ml. of suspension *A*, after irradiation, introduced into 1·9 ml. of non-irradiated buffer ; (*E*) 0·1 ml. of non-irradiated suspension, equal in concentration to *A*, introduced into 1·9 ml. of non-irradiated buffer (control).

The curves illustrate the fact that the rate of inactivation was identical for suspensions *A* and *B*, and that to produce this rapid rate of inactivation it was necessary (1) that the phage suspension be exposed to radiation, (2) that it should be in contact thereafter with irradiated buffer solution. A similar rate of inactivation was observed when irradiated phage was exposed to hydrogen peroxide at concentration 3×10^{-5} *M*, this being roughly the concentration of hydrogen peroxide which was produced in aerated water by 15,000 r. of 100 kV. X-rays[2]. The rate of inactivation for irradiated phage exposed to this concentration of hydrogen peroxide was more than fifteen times as much as that for non-irradiated phage exposed to the same concentration.

The enhanced susceptibility of irradiated phage to the action of hydrogen peroxide is an indirect effect of radiation, that is, it is presumably due to the radicals produced in the water during irradiation. The effect was observed in suspensions from which dissolved oxygen had been removed, as well as in fully aerated suspensions ; but it did not show in

the oxygen-free suspensions unless aliquots were introduced after irradiation into irradiated aerated buffer, or hydrogen peroxide solutions. It is, of course, well known[2] that X-rays do not produce hydrogen peroxide in oxygen-free water.

It was found (Fig. 2) that, during the X-irradiation of oxygen-free phage suspensions, inactivation proceeded initially at a rate which was certainly no slower than that observed in aerated suspensions. The rate of inactivation became greater in the aerated suspensions when reaction with hydrogen peroxide had begun to be perceptible. It is apparent, therefore, that during X-irradiation of phage the active radicals inactivate some of the phage particles and in others cause a change which increases their susceptibility to hydrogen peroxide; but for neither reaction is the presence of oxygen necessary. Oxygen enhances the inactivating effect of the radiation only because it is necessary for the formation of hydrogen peroxide.

Since deoxyribosenucleic acid forms a high proportion of the solid content of bacterial virus[4], it is of interest to compare these experiments with studies of the after-effects of X-rays on nucleic acid. Butler and Conway[5] found that, when irradiation ceased, the degradation of nucleic acid ceased under oxygen-free conditions; but it proceeded for many hours when oxygen was present during irradiation. The hydrogen peroxide produced in their irradiated solutions was, however, not of sufficiently high concentration to bring about an equivalent degradation in non-irradiated nucleic acid solutions. It seems possible that the change brought about during irradiation in bacteriophages *S*13 and *T*3 is, in fact, a change in the deoxyribosenucleic acid, which becomes susceptible to the action of hydrogen peroxide in concentrations much lower than those which would produce an equivalent degradation of non-irradiated material.

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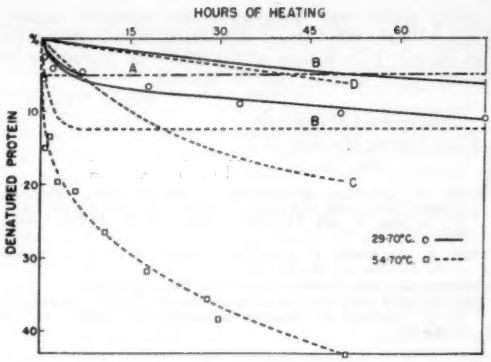
Effect of Ionizing Radiation on Protein Denaturation

IT has long been known that the stability of proteins with respect to denaturation (as defined by aggregation) is lowered upon treatment with ionizing radiation[1]. Detailed studies are lacking, however. We have found that the denaturation of solutions of egg albumin and hæmoglobin subjected to X-rays (the denaturation kinetics of which in the intact state is known[2]) can be defined quantitatively by the usual coagulation method, its validity being established by order of reaction studies on dilutions of the complex irradiated systems. By this procedure it was found that the heterogeneous protein material of these systems was (at ordinary *p*H) initially undenatured and contained relatively large quantities of species of decreased thermal stability, characterized by much reduced values of both the Arrhenius frequency factor (ν) and the energy of activation (E) of their first-order denaturation velocity-constants.



Thermal denaturation after irradiation with X-rays of 0·46 per cent egg albumin in *p*H 4·85, 0·1 *M* sodium acetate buffer + 0·1 per cent sodium sulphate. The protein was treated anaerobically with 33 kr. at 0° C. in *p*H 4·85 sulphuric acid. The curves through the experimental points were calculated from the constituent first-order terms *A*, *B*, *C* and *D*

The accompanying graph shows some of the results obtained in a thermal study (29·70°–59·20° C.) of an egg albumin system irradiated with X-rays. The whole body of kinetic data could be satisfactorily accounted for by four first-order terms *A*, *B*, *C* and *D* (*D*, protein of unaltered rate of denaturation), as illustrated for the two reaction curves in the graph. The yields (32·5 eV.) and values of ν and E were: *A*, yield, 0·075; $\nu = 10^{15}$ sec.$^{-1}$; $E = 26{,}000$ cal./mole; *B*, yield, 0·19; $\nu = 10^{20}$ sec.$^{-1}$; $E = 35{,}000$ cal./mole; *C*, yield, 0·34; $\nu = 10^{49}$ sec.$^{-1}$; $E = 81{,}000$ cal./mole. Intact protein (*D*) $\nu = 10^{80}$ sec.$^{-1}$; $E = 129{,}000$ cal./mole.

The large decreases in ν and E indicate serious structural injuries; but their exact nature is still uncertain. Some of the chemical changes in the irradiated proteins may be in structurally important side-groups; but such reactions would probably affect the stability to a relatively small extent only. Breakage of the peptide chain might provide an adequate mechanism; but no evidence has been obtained that such breakage occurs. No sign of fractionation was found under the conditions used; however, strong fractionation has been reported in solutions of serum albumin and hæmoglobin, treated with more massive dosages of α-rays[3].

With concentrations up to 1 per cent protein, these structural changes originate essentially in solvent activation, the rate being independent of protein concentration between 0·2 and 1 per cent, when other irradiation conditions were those of the graph. At higher concentrations, the direct effect becomes important. It is characterized by higher yields and more profound injuries, as judged by the changes in ν and E. The direct effect was studied also on solutions of irradiated solid egg albumin, under which condition a yield of 1·8 was found for the total quantity of protein of experimentally increased lability.

While denaturation appears generally to be of little importance in usual low-temperature work, it evidently requires consideration in the development of the field from the physiological point of view. It is presumably a principal factor in the well-known thermal after-effects found in the irradiation of protein enzymes, which are now beginning to attract quantitative attention[4].

This work was supported by research grant, Project *R.G.* 673, from the Division of Research Grants and Fellowships of the National Institutes of Health, U.S. Public Health Service.

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o-Aminophenol in Experimental Tuberculosis

In 1948 Okamoto[1] reported that *o*-aminophenol showed a tuberculostatic effect both *in vitro* and *in vivo* (in guinea pigs). He also referred to favourable progress when this drug was used clinically in pulmonary tuberculosis. In the course of a study of the chemotherapy of experimental tuberculosis, we have included *o*-aminophenol in our tests.

In vitro tests were carried out against the *H37Rv* strain of *Mycobacterium tuberculosis* var. *hominis*, using the floating pellicle method with serial dilutions of the drug in modified Long's medium plus 10 per cent ox serum. *o*-Aminophenol inhibited this strain for four weeks at a dilution of 1 in 729,000 but not at 1 in 2,187,000.

In vivo tests were carried out with both mice and guinea pigs. 18–22-gm. male albino mice were infected intracerebrally with 0·05 ml. of an undiluted 10-day old Kirchner Tween – albumin culture of the Ravenel strain of bovine tubercle bacilli. Treatment was commenced two days after infection and continued until the twenty-third day. All the surviving mice were killed twenty-eight days after infection. The extent of tuberculosis was assessed by the macroscopic extent of lung lesions using an arbitrary scale of 0–6.

500-gm. guinea pigs were infected intraperitoneally with 0·25 ml. of a 1 in 100 dilution of a 14-day old Tween – albumin culture of the *H418* strain of human tubercle bacilli. Drug treatment was commenced twenty-one days after infection when all pigs were tuberculin positive, and continued for sixty days, when all survivors were killed. The extent of infection was assessed by the method of Sher and Kloeck[2]; survival times and weight changes were also recorded. Streptomycin was used as an active drug control.

Mice			Guinea pigs			
Drug	Dose in mgm./ 20 gm. mouse/ day	T.B. index*	Dose in mgm./ 500 gm. guinea pig/ day	Individual T.B. assessments (maximum = 100, italics denote death)	T.B. index*	Weight gain in gm./ guinea pig over test period
o-Aminophenol	4	1·3	50	*30, 62, 48, 53·5, 64, 56·5, 63·5,* 65, 38, 36	1·2	None
	2	1·3				
Streptomycin			10	*22·5,* 8, 9, 9, 17	0·3	69
None (controls)	nil	1·0	nil	*33, 52, 36, 43,* 54·5, 51	1·0	40

* T.B. index = average T.B. assessment of drug-treated group divided by average assessment of untreated control group.

The drug dosages are shown in the table, together with the results. Both drugs were given subcutaneously in two doses (a.m. and p.m.) on five days a week. The *o*-aminophenol was given in water warmed to effect solution; streptomycin was given in saline.

The results in both mice and guinea pigs indicate that *o*-aminophenol caused no retardation of tuberculosis, although high *in vitro* activity was confirmed. There was macroscopic evidence of tissue damage at the site of injection of *o*-aminophenol in both animals. This did not occur with streptomycin.

I wish to thank Sir Jack Drummond and Mr. C. E. Coulthard for their interest in this work, and Mr. D. E. Williamson and Mr. L. Draper for help with the animal work.

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Isolation of Methoxy- and 2 : 6-Dimethoxy-*p*-benzoquinone from Fermented Wheat Germ

The addition of wheat germ to flour lowers its baking quality, as is at once obvious from the smaller volume of the loaf. Hullett[1] and Hullett and Stern[2] found that if the wheat germ is first fermented sufficiently with yeast, there is no fall in bread quality, and this coincides with the disappearance of the glutathione. Vuataz[3] has shown that the latter is due to combination of the glutathione with one of the fermentation products, which he isolated as a yellow crystalline compound, melting point 141–143° (decomp.) (I), and which he suggested was the unknown furfuryl glyoxal, $C_4H_3O.CH_2.CO.CHO$. During the isolation of this compound, a small amount of another substance, melting point 244–245° (decomp.) (II), was obtained. This did not react, however, with glutathione.

In December last, Dr. E. W. Hullett, director of the Wheat Research Institute, New Zealand, was in England, and directed the attention of one of us (T. M.) to this paper by Vuataz and the light it threw on his own earlier work. As a result, following a discussion with Dr. Hullett and Dr. E. Marsden, scientific adviser to the New Zealand Government, it was agreed that these laboratories should make a close study of substance (I); apart from its scientific interest, it was felt that such a study might possibly lead to developments in the field of flour improvers.

We have now repeated the isolation of these substances, using a slight modification of Vuataz's method, and have obtained similar yields of I and II, 0·05 per cent and 0·01 per cent respectively of the weight of germ. Our chemical and spectroscopic evidence does not, however, confirm the structure he suggested for (I). We find that it is methoxy-*p*-benzoquinone, melting point 143–144°, whereas (II) is 2 : 6-dimethoxy-*p*-benzoquinone, melting point

259–260°. The identity of both substances with authentic specimens[4,5] has been established.

So far as we are aware, this is the first instance of the isolation of simple benzoquinones from wheat germ or a yeast fermentation. Methoxy-*p*-benzoquinone has not previously been shown to occur naturally, but 2 : 6-dimethoxy-*p*-benzoquinone has been isolated from *Adonis vernalis* L.[6]. It is of interest that both these quinones have appreciable bacteriostatic activity *in vitro* against Gram-positive organisms[7]. Other substituted benzoquinones are, of course, of widespread occurrence in moulds, fungi and higher plants[8].

We have tested the activity of these compounds in bread-making, and have found (I) to be effective in improving both the volume and the crumb structure of bread, its optimum admixture with the flour being of the order of 60 p.p.m. (II) displays similar properties, though to a much lesser degree. Both substances, however, impart a pinkish-brown tinge to the bread, and this alone would rule them out as flour improvers. Among analogous compounds we have found that *p*-benzoquinone is effective at about 180 p.p.m. and has no adverse effect on the colour of the bread.

Full details of this and further work on the general problem will be published elsewhere.

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Uptake of Plasma Amino-acids by the Perfused Isolated Cow's Udder

Arterio-venous studies carried out on lactating udders of living cows have repeatedly led to the conclusion that the free amino-acids of the circulating blood are taken up by the gland[1]. Most authors agree that the observed arterio-venous differences in free amino-acids are inadequate to account quantitatively for the synthesis of the milk proteins—casein and lactalbumin. Other workers found an uptake of protein-bound carbohydrates by the udder of the lactating goat[2]. No uptake of amino-acids by the udder of the goat and the cow was found during inanition even though some milk was still being secreted[3]. Recently, carbon-14 labelled valine and carbon-14 labelled lysine were injected intravenously into lactating rabbits[3], and the activity of milk and blood proteins estimated. In both cases it was found that the milk proteins were highly radioactive. As this activity was much greater than that of the blood proteins, it was clear that the free amino-acids of the blood were being incorporated directly into the milk proteins.

We studied this uptake problem in the isolated lactating cow's udder perfused by the technique described earlier[4]. Both halves of the udder were perfused separately during 90–120 min. with 9 litres of oxygenated, heparinized blood at 38° C. Ten free essential amino-acids of the plasma were estimated microbiologically by the method of Henderson[5] and Hier and Bergeim[6]. Blood samples were taken at the beginning and end of the experiment. In a following series of experiments, only three amino-acids (*iso*leucine, leucine and lysine) were estimated in samples taken from the perfusion liquid at 0, 30, 60 and 90 min. after the beginning of the experiment. Results of these determinations are given in Tables 1 and 2.

Table 1. Concentration of Ten Essential Free Amino-acids in Perfusion Liquid at the Beginning and End of the Experiment
Values are expressed as γ per ml. plasma

	Beginning	End		Beginning	End
Arginine	27·0	14·1	Methionine	9·3	2·4
Histidine	25·5	17·4	Phenylalanine	12·6	7·1
*iso*Leucine	35·1	11·4	Threonine	8·1	6·3
Leucine	30·0	7·2	Tryptophane	7·2	6·0
Lysine	29·1	9·0	Valine	35·7	15·6

Table 2. Concentration of *iso*Leucine, Leucine and Lysine at Different Times of Perfusion
Values are expressed as γ per ml. plasma

	0 min.	30 min.	60 min.	90 min.
*iso*Leucine	15·9	9·6	6·0	4·2
Leucine	27·0	14·1	9·0	6·6
Lysine	16·0	9·6	5·5	3·6

It is worth noting that the decrease of amino-acids in the plasma is more or less proportional to the concentration of the amino-acids in milk proteins. We found the greatest decrease for *iso*leucine, leucine, lysine and valine, which also have the highest concentration in milk proteins.

Our results agree with those obtained by other workers and indicate that at least some of the milk proteins are formed in the gland from free blood amino-acids. Our results also show that the perfusion technique of the isolated cow's udder might offer attractive possibilities for studies of protein synthesis.

These experiments will be fully described elsewhere.

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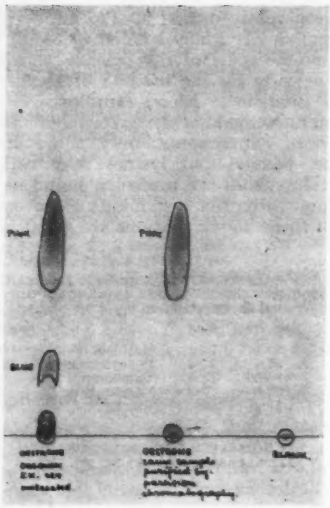
Purification of Commercial Samples of Œstrone

Paper chromatography of the *p*-nitrobenzene-azodimethoxyaniline ('Fast Black Salt *K*') derivatives of two commercial samples of œstrone, according to the method described by Heftmann[1], revealed the presence of small traces of an impurity which appeared as a blue spot with lower R_F value than the pink œstrone dye. This substance could be removed from the œstrone by means of partition chromatography on a 'Celite'–sodium hydroxide column, following the method of Swyer and Braunsberg[2]. Paper



chromatograms, run before and after purification by our technique, showed that the impurity was completely removed by this means (see photograph).

Equilenin, on treatment with 'Fast Black Salt *K*', gave a blue spot of similar R_F value to that of the impurity, suggesting that the latter consisted of this compound.

This method constitutes a convenient way of purifying small quantities of œstrone, which are recovered quantitatively. A similar technique was used by Haenni[3] to separate the œstradiols, α-dihydroequilin and the dihydroequilenins while this work was in progress.

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An Unknown Amino-acid occurring in the Rock Lobster (*Jasus lalandii*)

In the course of an investigation (to be reported elsewhere) of press liquor, a waste product of the South African rock lobster industry, it was necessary to examine certain nitrogenous fractions. The solute in de-proteinized (trichloroacetic acid) press liquor was found to consist almost entirely of free amino-acids. A phenol/lutidine chromatogram showed an unknown substance giving a pink to pink-purple colour with ninhydrin. From its position on the chromatogram, it could be either methionine sulphoxide, or the '*T*-spot' (β-amino*iso*butyric acid) of Crumpler, Dent, Harris and Westall[1]. The first possibility was disproved by oxidation with hydrogen peroxide in the presence of molybdate; the unknown appearing in its usual position, unlike the sulphoxide, which is oxidized to the sulphone and appears elsewhere on the chromatogram.

Further investigations cast doubt on the second possibility. On a column of cation exchange resin, 'Zeo-Karb 215', the unknown appears with the glycine, alanine and proline fractions, and not between the leucine and histidine fractions, as reported for the '*T*-spot' by Crumpler *et al.* Furthermore, it forms a copper complex under the conditions employed by Crumpler and Dent[2]. Taurine and γ-amino-butyric acid (sample kindly supplied by Dr. C. E. Dent) were used as markers during these experiments, and showed up as clearly on the copper-treated chromatograms as on the untreated ones; any α-amino-acids added disappeared after the copper treatment, thus showing the technique to be without fault.

A small quantity of the unknown substance was obtained by preparative paper chromatography and was hydrolysed in a sealed tube with 20 per cent hydrochloric acid for 42 hr. at 135°. After this treatment, the unknown still appeared in its usual position on the chromatogram. This precludes the possibility of its being a peptide and raises further doubt as to its identity with β-amino*iso*butyric acid, since the β-amino-acids are known to be unstable to even mild acid hydrolysis[2].

It would appear from the evidence given that the unknown substance is not identical with the '*T*-spot' of Crumpler *et al.*, and this serves to emphasize the care that must be exercised in the interpretation of chromatograms of hitherto uninvestigated materials.

Whether run in neutral or ammoniacal phenol, the substance has the same R_F value and therefore would not appear to be basic. The evidence available points to the conclusion that the unknown is a new α-amino-acid, possibly a monoamino monocarboxylic acid.

Of the function this acid plays in the rock lobster nothing is known; it may perhaps be a regulator of osmotic pressure[3].

Isolation of the new acid on a larger scale is in progress with the view of determining its structure.

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A Crystalline Constituent from Myogen of Carp Muscles

Electrophoresis of aqueous extracts of minced carp muscles after dialysis against water reveals one main gradient corresponding to 80–90 per cent of the myogen[1]. After prolonged electrophoresis, this gradient separates into several constituents, the most important having a mobility of -3×10^{-5} cm.^{2}/volt/sec. (ascending) and $-2{\cdot}5$ cm.^{2}/volt/sec. (descending) in phosphate + sodium chloride, μ 0·15, *p*H 7·3.

We have succeeded in isolating and crystallizing a protein of this mobility by the following method. Fresh minced carp muscles are extracted with 1 volume water at 0° C. for an hour. After dialysis against water and removal of the precipitate by centrifugation, solid ammonium sulphate is added to the extract up to 40 per cent saturation. The precipitate is discarded and the supernatant is brought to 55 per cent saturation by addition of

saturated ammonium sulphate, *p*H 7·1. The precipitate is centrifuged off and dissolved in the minimum of water. Solid ammonium sulphate is added up to slight turbidity (*p*H is then 6·4–6·6). Very thin needle-like crystals separate within an hour.

The crystals increase in size after standing (see photomicrograph). This crystalline material is homogeneous in the ultracentrifuge. Prolonged electrophoresis at μ 0·10, *p*H 7·6 reveals a very small amount of impurity separating from the main gradient.

The fraction isolated is the first crystalline component isolated from fish myogen. Preliminary steps are being undertaken to examine its enzymatic properties. Tests for aldolase and *d*-3,glyceraldehyde-phosphate-dehydrogenase gave negative results.

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Occurrence of Plasmalogens in Vegetable Phosphatides

The plasmalogens[1,2] are a group of phospholipids containing a higher fatty aldehyde in the molecule. Until recently, the only recognized structure for these compounds was that of acetals of α-glyceryl-phosphoryl-ethanolamine[3]. Klenk and Böhm[4] have now extended the group to compounds containing serine instead of ethanolamine, and I[5] have also obtained evidence of the existence of plasmalogens with a base other than ethanolamine. There seems every reason to expect that the plasmalogens will be found to show structural similarities to a number of the classical phospholipids.

So far, plasmalogens have only been reported as constituents of animal phosphatides, where their distribution is very uneven. Thus muscle phosphatides contain about 10–12 per cent of fatty aldehydes ('plasmals'), brain phosphatides about 8–10 per cent, liver phosphatides 1 per cent and egg lecithin less than 0·1 per cent[3]. The accepted type of plasmalogen contains about 56 per cent of plasmal. Through the kindness of Messrs. J. Bibby and Sons, Ltd., Liverpool, I have had the opportunity of examining specimens of total phosphatide fractions from groundnut and soya bean. The method of Feulgen and Grünberg[6] for plasmalogen estimation had to be slightly altered since the vegetable phosphatides proved to be only partially soluble in acetic acid. The samples were dissolved in 1 ml. of light petroleum (boiling point 40–60° C.), which was shaken overnight with the Feulgen and Grünberg reagent. The standard (palmitaldehyde) and blank determinations were, of course, modified in the same way. The colour was afterwards extracted in each case into chloroform. Both the vegetable phosphatides contained aldehyde equivalent to about 7 per cent of palmitaldehyde. Groundnut phosphatides have been shown to contain both ethanolamine and serine[7] and soya bean phosphatides to contain ethanolamine[8,9], so that there is no reason to suppose that the aldehyde found is not present as the conventional type of plasmalogen.

Vegetable phosphatides have been far less intensively studied than animal phosphatides. The present findings, therefore, are not only of significance in extending the known distribution of the plasmalogens, but also as providing further evidence of some common phospholipid patterns between animals and plants.

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Cytochrome *c* and *in vitro* Formation of Bile Pigments

This communication describes the attempted *in vitro* conversion of cytochrome *c* to bile pigments, using coupled oxidation with ascorbic acid[1], and forms part of a systematic study of the relationship of chemical structure to bile pigment formation[2,3].

Cytochrome *c* is of particular interest in this problem, since Theorell[4] has shown that its hæm is deeply embedded in the protein. Two iron–imidazole linkages confer its hæmochrome structure, while side-chains 2 and 4 are also firmly attached to protein through cysteine residues[5], endowing the molecule with great stability to acid and alkali, and a non-separable prosthetic group. Cytochrome *c* does not react with oxygen or carbon monoxide, and it is possible to remove its iron atom without breaking the attachment of hæm to protein.

Bigwood and Thomas[6] and Lemberg and Wyndham[7] have obtained spectroscopic evidence for verdohæmochrome arising in the preparation of cytochrome *c*, but bile pigment formation has not been investigated.

In the present research, cytochrome *c* was prepared according to Keilin and Hartree[8] with iron content 0·34 per cent and absorption spectrum of ferricytochrome *c* 564·2 and 529·2 mμ. 50 ml. cytochrome solution (≡ 10 mgm. or 7 mgm. hæmatin) was incubated with 100 mgm. ascorbic acid in Petri dishes in air at 37° for 2 hr. No change of colour

was observed in the solution, the final absorption spectrum being 623·1 (weak), 550·1 and 529·5 mμ. Reduction with dithionite gave the two intense bands only, 550·1 and 519·7 mμ, of ferrocytochrome *c*. Subsequent treatment employed either acetic acid, or acetone-hydrochloric acid as described by Bonnichsen[8]. Bile pigments were determined fluorimetrically as bilipurpurin–zinc complex[2].

No bile pigments were detected in any one of the several trials. Since hæmochromes react readily in coupled oxidation with ascorbic acid to give high yields of bile pigment, it appears probable that the firm thio-ether linkages between protein and the 2 and 4 side-groups in cytochrome *c* provided an over-riding obstacle to *in vitro* bile pigment formation.

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Interaction of Dextran and Fibrinogen

Because of its use in blood transfusion as a substitute for plasma[1], the interaction of dextran with plasma proteins is of considerable interest. The present communication reports an apparently non-specific interaction of dextran with fibrinogen.

When 2-ml. volumes of two saline solutions containing 6 per cent dextran and 1·45 per cent fibrinogen were mixed at 22° C., the formation of a bulky flocculent precipitate was observed. Analysis showed that the precipitate contained 13 per cent of the available fibrinogen. Precipitation occurred with dextran of British and Swedish origin and fibrinogen prepared in Britain and the United States.

Simple mixing experiments with appropriate controls revealed that the formation of a precipitate was strongly dependent on the concentration of dextran and fibrinogen, being less at the lower concentrations, below about 1·5 per cent dextran and 0·31 per cent fibrinogen. Precipitates were formed with dextran samples having intrinsic viscosities between 0·64 and 0·11, but not with a sample of intrinsic viscosity 0·04. Precipitation was favoured by decreasing temperature in the range 37°–0° C., sodium chloride concentration in the range 9–0·9 per cent and *p*H in the range 8–6. After separation in the centrifuge the precipitate was soluble in saline. This solution formed a firm clot when thrombin was added.

In a further experiment in which 5-ml. volumes of 5·3 per cent dextran (intrinsic viscosity 0·32) and 1·1 per cent fibrinogen were mixed, the precipitate and supernatant solution were analysed for dextran by the procedure of Hint and Thorsen and for fibrinogen by micro-Kjeldahl determination. The precipitate contained 3 mgm. of dextran and 5 mgm. of fibrinogen, 1 per cent of the dextran and 9 per cent of the fibrinogen being precipitated.

The importance of this reaction lies in the possibility of its occurrence *in vivo*. In experiments to determine the fate of dextran, laboratory animals may receive sufficient dextran to form a precipitate with their fibrinogen. Insoluble matter in the blood stream is ordinarily deposited in cells of the reticulo-endothelial system. This offers an explanation of previous experiments in which the persistence of dextran in tissues rich in these cells was noted[1].

Reactions to dextran in man are rare and difficult to investigate. These observations may contribute to their elucidation.

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Evoked Single Cortical Unit Activity in the Primary Cortical Receiving Areas

Renshaw *et al.*[1] analysed single cortical cell activity in the hippocampus by means of a micropipette electrode. Since 1951, the technique has been used by us for isolating peripherally evoked single cortical unit activity in the primary somatosensory, auditory and visual receiving areas of the cat and the monkey. Either barbiturate (dial or nembutal), chloralose or magnesium sulphate anæsthesia was used. The preparation was frequently paralysed with *d*-tubocurarine or *B*-erythroidine. The micro-electrodes used were either nichrome wire sharpened to a tip diameter of 6–10 μ and insulated to the tip, or glass micropipettes, drawn to a tip diameter of 4–12 μ. The latter were filled with 3 *M* potassium chloride to reduce their resistance[2] and led into a cathode follower input. Action potentials were conventionally amplified (both r.c. and d.c. coupling) and displayed on twin-beam cathode-ray oscilloscopes. The cortex was fixed in 10 per cent formalin, sectioned at 50 microns and stained with thionin for identification of electrode tracks.

Independent results were combined for the present communication and will be presented in detail elsewhere. A total of 164 single cortical units were studied, including 90 units in feline somatosensory areas I and II, 27 units in feline auditory area I and II and 15 units in feline visual area I. Eighteen units were studied in somatosensory area I of macaque and cynomolgous monkeys. The corresponding figures for primate auditory and visual areas were 11 and 3 units. Where recordings were taken from exposed feline cortex, the micro-electrode tip lay 0·7–1·8 mm. below the pial surface.

The great majority of the unit potentials were initially negative in sign (duration 0·3–0·64 msec.). A subsequent positive deflexion followed which was variable and of longer duration. The amplitude of the negative phase reached 3 mV. but usually measured about 0·5 mV. The latency of the evoked discharge differed greatly from unit to unit. Under either barbiturate or chloralose anæsthesia, some cortical cells commenced firing even before the peak of the primary positive response recorded from the pial surface, suggesting that they may be partly

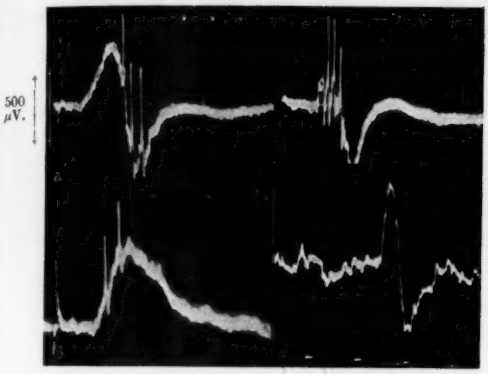

Fig. 1. Patterns of single soma activity in feline somatosensory areas I and II. (*a*) Unit firing after peak of primary response. Unit recorded just anterior to cruciate sulcus. Chloralose-tubocurarine anæsthesia. Stimulus to contralateral ulnar nerve. Time interval, 10 msec. (*b*) Unit just behind cruciate sulcus and 1·2 mm. deep. Chloralose *B*-erythroidine. Time interval, 10 msec. (*c*) Unit anterior to ansate sulcus. Chloralose-tubocurarine. Time interval, 10 msec. Shock indicated by dot below trace. (*d*) Fast sweep from unit in area II at 1·5 mm. depth. Contralateral median nerve stimulated. Dial. Time interval, 1 msec. In all records microelectrode negativity indicated by upward deflexion of trace. Voltage calibration refers to upper records. Note primary response reversed in sign. (V. E. Amassian)

responsible for the latter. The number of spikes per response varied from one to seven. The highest rate of discharge observed was 1,000/sec.

It is difficult to reconcile these findings with those reported recently by Cragg[3]. In view of the consistency of our findings in all three major sensory receiving areas of the cat and the monkey under a wide variety of experimental conditions, it seems worth while to comment upon these discrepancies. We have never seen wave-forms such as those presented in Fig. 1 (*b*1) of Cragg's communication, except when recording with a defectively insulated metal electrode, or when inadequate precautions have been taken to minimize movement of the brain with respect to electrode or electrode polarization. The reported maximal spike amplitude of 35 mV. is certainly very surprising. We never obtained amplitudes greater than 3 mV. without damaging the unit, with subsequent injury discharge and/or abrupt depolarization, although electrodes as small as 4 μ were often used. Somewhat similar techniques in the hands of Lloyd[4], Renshaw[5] and others working with the spinal cord have yielded potentials up to 6 mV., but not much more. An amplitude of 35 mV. would suggest that the microelectrode tip lay within the cell, were it not for the fact that the unit in Fig. 1 (*b*1) is negative in sign. We feel that a minimum criterion for identification and analysis of cortical single-unit records is reproducibility of unit firing over at least two stimulus cycles, using sufficiently fast sweep speeds to obtain clear resolution of individual spikes in the high-frequency burst. Such a standard is not at all difficult to attain, and cortical unit activity must be followed for several minutes before conclusions can be safely drawn.

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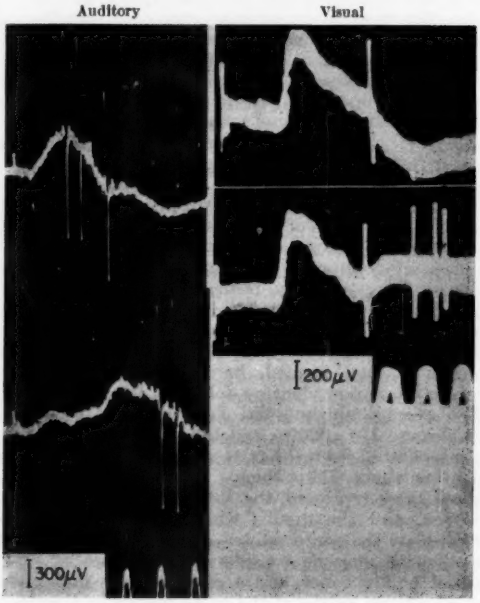

Fig. 2. (*a*) Unit in auditory sensory area I of the cat responding to click stimulus in contralateral ear (top record) and in ipsilateral ear (bottom record). Note differences in latency and pattern of response. (*b*) Unit in visual sensory area I of the cat responding to gross photic stimulation. Note variation in pattern. Time calibration, 60 c./s. Upward deflexion, microelectrode negative. (L. B. Thomas)

Amassian and Thomas are somewhat bold in implying that the complexities of the cortex can be reduced to no more than these simple and consistent patterns of response. Apart from their use of paralytic drugs, the main difference between our techniques lies in the size of electrodes used; mine were "of less than 5 μ diameter" and the action potentials of many millivolts amplitude were recorded only from electrodes of about 1 μ tip diameter. It is probable that electrodes of 4–12 μ tip diameter record distinct action potentials only from particularly large cells, which tend to be well separated, and this may be responsible for the simple and consistent responses obtained. Regarding the reproducibility of small electrode recordings, I have found that in a long series the number of action potentials evoked by a stimulus may vary widely; but there is a fairly constant latency at any one locus for the first appearance of action potentials belonging to a given group.

I should like to take this opportunity of pointing out an error in the reproduction of my photographs in *Nature* of February 9, p. 240; all the calibration arrows should have been 6·8 mm. long on the scale used.

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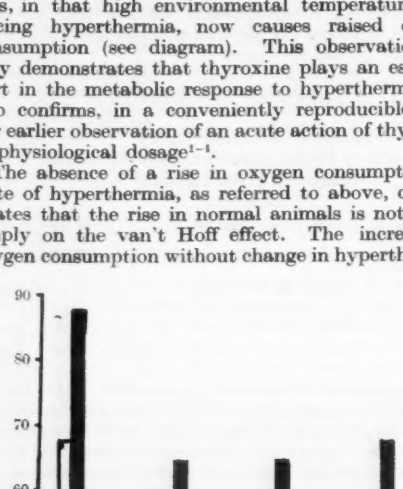
Effect of High Environmental Temperature on the Oxygen Consumption of Thyroidectomized, Hypophysectomized and Methylthiouracil-treated Rats and the Related Action of Thyroxine

It is well known that oxygen consumption increases if the temperature of the environment is raised above the neutral zone (28°–30° for the rat). Normal rats, in a chamber saturated with water vapour, invariably respond to a temperature of 35° C. with a marked rise in oxygen consumption.

We have failed to observe a similar rise, at this temperature, in most thyroidectomized and hypophysectomized rats, and in rats receiving thiouracil over a long period. In these animals oxygen consumption either remained unchanged or was diminished in spite of hyperthermia, and, in most instances, a rise in oxygen consumption failed to appear even at environmental temperatures of 37–38° C. or higher, and with body temperature approaching or often exceeding 40° C. If a few micrograms of thyroxine is administered subcutaneously to these animals, they behave as do normal rats, in that high environmental temperature, producing hyperthermia, now causes raised oxygen consumption (see diagram). This observation not only demonstrates that thyroxine plays an essential part in the metabolic response to hyperthermia but also confirms, in a conveniently reproducible way, our earlier observation of an acute action of thyroxine in physiological dosage[1–4].

The absence of a rise in oxygen consumption, in spite of hyperthermia, as referred to above, demonstrates that the rise in normal animals is not based simply on the van't Hoff effect. The increase in oxygen consumption without change in hyperthermia, which occurs after thyroxine, indicates that this metabolic response is not due, as is widely assumed, to the activation of thermo-regulatory mechanisms serving heat loss. Details of this work will be published elsewhere[5].



Oxygen consumption of the rat in various circumstances. (1) Normal rat : ▯ at 29° C., ▮ at 35° C. environmental temperature.

(2) Thyroidectomized rat : ▯ at 29° C., ▮ at 36° C. environmental temperature : (*A*) before thyroxine, (*B*) after 5 μgm. of thyroxine. Body temperature (in an environment at 36° C.) before thyroxine 38·8° C., after thyroxine 38·8° C.

(3) Hypophysectomized rat : ▯ at 29° C., ▮ at 35° C. environmental temperature : (*A*) before thyroxine, (*B*) after 5 μgm. thyroxine. Body temperature before thyroxine (environment 35° C.) 38·3° C., after thyroxine 38·5° C.

(4) Thiouracil-treated rat : ▯ at 29° C., ▮ at 37° C. environmental temperature : (*A*) before thyroxine, (*B*) after 10 μgm. thyroxine. Body temperature (environment 37° C.) before thyroxine 39·3° C., after thyroxine 39·3° C.

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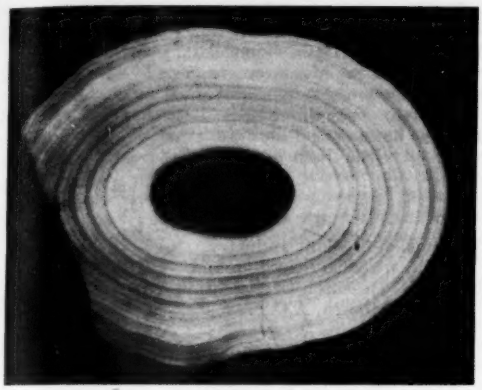
A New Method of Age Determination for Mammals

For estimating the age of mammals such widely differing characters as coat colour, size, skull proportions and sutures, ossification, numbers of corpora albicantes, changes in the lens of the eye, etc., have been used ; but such methods are laborious and frequently yield only an approximate result. While working on the elephant seal (*Mirounga leonina*) in 1949, a new and accurate method of determining age, depending upon cyclical variation in the rate and manner of calcification of the teeth, was developed. This makes possible determination of age, to within a month, up to at least twenty years in the male, and thirteen years in the female.

The permanent canine teeth of the elephant seal erupt within a few days of birth and grow throughout life ; the pulp cavity remains open and attrition is negligible. The other teeth cease to grow at an early age. In this species the yearly cycle is remarkable in that in the adult there are two periods of complete or partial fasting, corresponding to the mating season and to the annual moult. In younger animals there are three or more short periods of fasting. These fasts appear to be correlated with changes in the general metabolism and are represented in the structure of the canine teeth throughout life. Microscopic examination of thin ground sections of elephant seal canines shows a stratification of alternating zones of 'columnar' and marbled[1] dentine. The former are more dense than the marbled zones and are visible macroscopically as light-coloured rings which vary in thickness and are arranged in a definite pattern. The simplest pattern consists of an outer, first formed, light ring, then a narrow region of darker dentine followed by a light ring. The average thicknesses of these zones in a male canine are 330 μ, 200 μ and 168 μ respectively. They are separated from the next set by a zone of marbled dentine about 312 μ thick. It is believed that the three rings represent the breeding season, a period at sea, and the moult, while the wide dark ring represents the winter at sea. The annual increments of dentine may be considered as a series of superposed hollow cones, and a discontinuity in the rate of growth in length of the tooth results in a series of annular ridges on the root, which, by deposition of cementum, become progressively obscured. This is markedly so in teeth of the hooded seal (*Cystophora cristata*), which have very clear rings in cross-section,



Cross-section of lower canine tooth of male elephant seal, 110 months old, showing nine annual zones of growth

and an exceptionally thick layer of cementum obscuring the annulations. Independently, and approximately contemporaneously, Scheffer[2] has developed a method based on the annular ridges of the roots of canine teeth of the northern fur seal (*Callorhinus ursinus*). Masking of the ridges by cementum makes these much less accurate as a means of determining age in most species than are the rings seen in cross-sections.

In cutting cross-sections (with a hacksaw) the cut must be made above the level of the first annulus on the root and so as to include part of the pulp cavity. In practice, the cut is made at the level of the alveolar bone. The sections are polished before examination. Then the number of complete groups of rings is counted and the age in months obtained by adding the number of months elapsed since the median date of the pupping season.

The validity of the method has been confirmed. For 227 elephant seals examined there is a positive correlation between the body length and the number of supposedly annual growth zones. Examination of the teeth established that formation of the zones occurs annually and regularly at particular seasons. Scheffer states that the annular ridges at the base of the tooth correspond with the known age of fur seals branded as pups.

Concentric rings, which, by analogy with the elephant seal, may probably be used in determining age up to the closure of the pulp cavity, have been observed in cross-sections of the teeth of the following species: *C. cristata*, *Hydrurga leptonyx*, *Phoca vitulina*, *P. grœnlandica*, *Lobodon carcinophaga* and *Leptonychotes weddelli*. The sperm whale (*Physeter catodon*) exhibits similar groups of concentric rings in cross-sections of the teeth, and a superficial examination of material in museums indicates that the teeth of a number of other vertebrates, living and fossil, have internal rings or external ridges which, like those found in seals, may possibly be used for determining age.

A detailed paper has been prepared and will appear shortly in the Falkland Islands Dependencies Survey Scientific Publications.

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Some Electrical Differences between Healthy and Virus-infected Potato Tubers

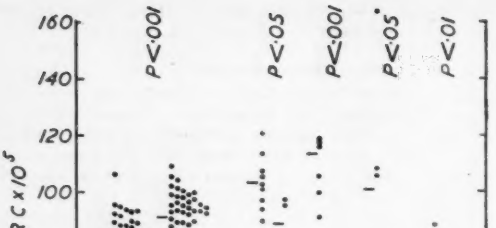
Successful electrical diagnosis of living and dead roots[1] suggested that it might be possible to distinguish between healthy and virus-infected tissues by similar measurements. Related examples of the application of electro-diagnosis are the investigations of Crile[2], who reported a difference in capacitance between benign and malignant tumours, and of Brazier[3], who showed that thyrotoxicosis could be diagnosed by an abnormal phase angle. Measurements on similar batches of healthy and virus-infected potato tubers have shown some significant differences in their electrical properties; but no reliable method of using these differences to distinguish between tubers has so far been developed.

In the following investigations, healthy and virus-infected tubers of the same degree of maturity were used. Unless otherwise stated, the tubers were grown at the Dickson Experiment Station, A.C.T. Two short metal pins[1] at the end of a glass tube were inserted into a tuber, in most cases at the rose end, and the impedance between the two pins determined on a suitable bridge at a frequency of 10 kc./s. At this frequency, polarization effects at the electrodes were small enough to be neglected. The results were measured in terms of an equivalent resistance R in parallel with a capacitance C. In general, the product $R.C$, which is a function of the phase angle of the tuber and should be independent of the probe and tuber dimensions, was used as a basis for discrimination.

Virus X. In a preliminary experiment with very immature Up-to-date tubers, it was found that any of the six healthy tubers gave a higher capacitance value than any of the six diseased tubers ($p < 0.02$). With more mature tubers, similar discrimination by capacitance was not observed, but the independence of the product $R.C$ with respect to the probe and tuber dimensions was confirmed.

Subsequent measurements on three different lots of Up-to-date tubers showed that for each lot the mean value of $R.C$ of the diseased batch was greater than that for the corresponding healthy batch ($p < 0.05$, $p < 0.001$, $p < 0.001$). The values for the most mature lot, measured five weeks after being dug, are plotted at A in the accompanying diagram. It was noticed in these three lots that with increasing maturity the mean value of $R.C$ decreased for both the healthy and the diseased batch. It was also calculated for the most mature lot that the mean impedance value of the healthy batch was greater than that of the diseased batch (9,461 ohms against 8,358 ohms, $p < 0.01$).

In the above experiments the healthy batch of tubers did not come from the same clone as the diseased batch. Although there was no reason to suspect any physiological differences between the two clones, further measurements were made on tubers from the same clone. Tubers kept for some twenty weeks in storage were used; they were wrinkled and sprouting, though in good condition as seed material. For each of the four clones of Up-to-date and Bismarck potatoes, it was found that the mean value of $R.C$ of the diseased batch was significantly less than that of the healthy batch. The values for the Up-to-date tubers are indicated at B in the diagram.



Frequency distribution of values of *R.C* for Up-to-date potato tubers. *H*, healthy tubers; *X*, tubers infected with virus *X*. *R* is measured in ohms; *C* in pfd. The batch means are indicated by horizontal lines

Leaf roll. Similar measurements were made on tubers with primary leaf roll infection. In this case, the healthy and diseased batches came from the same clone.

The 1950 measurements were made on tubers stored for about twenty weeks, the 1951 measurements on tubers stored for about nine weeks. The internal measurements were made on halves obtained by cutting the tuber at right angles to the long axis; the vascular ring measurements were made with the probe points straddling the vascular tissue.

The accompanying table summarizes the results obtained. It will be seen that for some varieties there were significant differences between diseased and healthy batches, whereas for other varieties the differences were not significant. This dissimilarity between certain varieties is not surprising, as varieties differ in their physiological response to leaf roll. It will be noted that in clone 47–20 there is a discrepancy as regards the differences between the rose end measurements for the 1950 and 1951 series. This discrepancy is somewhat similar to that already noted for virus *X*, between the *A* and *B* series in the diagram.

There was no significant difference between mean values for corresponding 47–20 batches grown in different soils at the Dickson Experiment Station and at Black Mountain (four miles apart).

Variety	Year	Portion	*R.C*	Signif.	Impedance	Signif.
84–7	1950	Stem end	$H > V$	n.s.	$H < V$	n.s.
,,	,,	Rose ,,	$H > V$	$< 0{\cdot}01$	$H > V$	n.s.
47–20 (Dickson)	,,	Stem ,,	$H < V$	$< 0{\cdot}01$	$H < V$	$< 0{\cdot}001$
,,	,,	Rose ,,	$H > V$	n.s.	$H < V$	$< 0{\cdot}001$
47–20 (Black Mt.)	1951	,, ,,	$H < V$	$< 0{\cdot}01$	—	—
47–20 (Dickson)	,,	,, ,,	$H < V$	$< 0{\cdot}001$	—	—
Katahdin	,,	,, ,,	$H > V$	n.s.	—	—
Sequoia	,,	,, ,,	$H < V$	n.s.	—	—
Sebago	,,	,, ,,	$H > V$	n.s.	—	—
Up-to-date	,,	,, ,,	$H < V$	$< 0{\cdot}01$	—	—
,,	,,	Stem ,,*	$H < V$	n.s.	—	—
,,	,,	Vasc. ring*	$H > V$	n.s.	—	—
,,	,,	Medulla*	$H < V$	n.s.	—	—

* Measurements made six weeks after rose end measurements. *H* represents mean value for healthy batch, *V* mean value for leaf roll batch.

We are continuing these investigations using the same clones for the healthy and diseased batches, to determine how the impedance and phase angle change with maturity. Measurements are being made over a wide frequency-range, and it is hoped from these to explain the differences between healthy and diseased batches and obtain further knowledge of the action of virus diseases on tissues.

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D. O. Norris
R. D. Brock

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A. M. Thompson

Division of Electrotechnology,
Commonwealth Scientific and
Industrial Research Organization,
Sydney, N.S.W.
Feb. 11.

[1] Greenham, C. G., and Crle, D. J., *Nature*, **164**, 669 (1949); *Aust. J. Agric. Res.*, **1**, 103 (1950).
[2] Crile, G. W., *J. Cancer Res.*, **9**, 388 (1925).
[3] Brazier, M. A. B., *J. Inst. Elect. Eng.*, **73**, 204 (1933).

Naphthoquinones from *Diospyros hebecarpa*

Diospyros hebecarpa A. Cunn. is a small or medium tree which is common on the tropical coast of Queensland and has been suspected of poisoning livestock[1]. As other *Diospyros* species are reported to contain plumbagin[2], it seemed possible that this is the toxic substance in *D. hebecarpa*. We have found that plumbagin is present in the leaves and bark of this species, and in addition we have isolated from the fresh leaves and immature fruits a new colourless crystalline compound, melting point 112–113° C., with the composition $C_{11}H_{10}O_3$. In chemical properties and absorption spectrum this substance closely resembles β-hydrojuglone and β-hydroplumbagin, which are also colourless when pure. On oxidation with ferric chloride it gives a quinone, melting point 125–126° C. ('Pyrex'), which is an isomer of plumbagin. (This quinone melts with decomposition at a much lower temperature in soda glass. Juglone behaves similarly, and its melting point may be raised to 164–165° C. in 'Pyrex' glass.)

With dimethyl sulphate and alkali the natural product gives a trimethyl ether, melting point 112–113° C., which does not depress the melting point of a synthetic sample of 2-methyl-4,5,8-trimethoxynaphthalene. The new quinone is evidently 7-methyljuglone, and it is noteworthy that the structural features of this compound are found in several naturally occurring anthraquinones.

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Commonwealth Scientific and Industrial
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Dec. 13.

[1] Webb, Commonwealth Sci. and Indust. Res. Org. Bull. 232 (1948).
[2] Meyer, *Rec. trav. chim.*, **66**, 193 (1947). Paris and Moyse-Mignon, *C.R. Acad. Sci., Paris*, **228**, 2063 (1949).

Speciation of Polychætes in the Clyde Sea Area

ISOLATION is regarded as an important factor in speciation, and when the population isolated is small its divergence from the main stock is more rapid than when it is large. Most of the evidence in support of current theories of the mechanism of speciation has come from the study of terrestrial and freshwater organisms. The difficulties involved in studying speciation in marine animals are obvious. Apart from the difficulty of collecting adequate samples, there is the additional one that there are fewer barriers which can serve to isolate populations, and so the phenomenon is likely to be much less marked.

A surprising number of polychætous annelids from the Clyde Sea Area (west coast of Scotland) show morphological differences from the typical forms. These divergent animals may be awarded the following taxonomic status:

(*a*) Species (large or important differences).

Lumbriconereis hibernica McIntosh (Eunicidæ)[1]; probably derived from *L. impatiens* Claparède.

Spiochætopterus sp. (Chætopteridæ)[2]; differs from *S. typicus* Sars in the form of the chætæ and in the number of thoracic segments.

Amage scotica Clark. (Ampharetidæ)[2]; differs from *A. gallasii* Marion in the number of branchiæ, bodily proportions and disposition of chætæ.

(*b*) Varieties (moderate differences).

Lepidasthenia argus Hodgson (Aphroditidæ); notopodial chætæ may be reduced in number or completely absent.

Drilonereis filum (Claparède) (Eunicidæ); eyes present.

Scolelepis fuliginosa (Claparède) (Spionidæ); eyes absent.

Tharyx marioni (St.-Joseph) (Cirratulidæ); eyes present, branchiæ on fewer anterior segments than usual.

(*c*) Intraspecific variation (small differences).

Harmothœ spinifera Ehlers (Aphroditidæ); first pair of elytra coloured.

Pista cristata (Müller) (Terebellidæ); branchiæ reduced in size.

Euchone rosea Langerhans (Sabellidæ); anal groove extending farther forward than normally.

Why variants should appear in 4–5 per cent of the polychæte species known from the Clyde cannot be answered directly; but there are three possible explanations, of which two seem less likely than the third. The Clyde Sea Area might be considered as a more or less self-contained body of water and so the fauna inhabiting it would be relatively isolated from that outside. The geography of the Firth of Clyde and what little biological evidence there is[3] suggest that this is an unlikely hypothesis. Secondly, the intolerance shown by polychæte larvæ at metamorphosis to unusual substrata might result in the formation of small isolated groups of those species which show variations. The substratum in the Clyde is, in places, extremely patchy and variable, although there is a deposit of mud over most of the area; but it is in this mud that the variants have been found. There remains a third possible explanation. The comparatively fragmentary knowledge of the breeding habits of polychætes has been summarized by Thorson[4]. This may be an unreliable guide to the habits of Clyde worms, because little is known about geographical variation of breeding habits; however, it appears that, with the exception of *Spiochætopterus*, all the species which occur in the Clyde as variants have probably lost their pelagic larval phase. It is at once obvious that this would lead to the rapid establishment of small, interrelated and interbreeding populations of each species, whatever the nature of the substratum. There remains a few species which have no pelagic larvæ but in which, so far, no variants have been found. A search is being made to see if these exist and if similar variants occur outside the Clyde Sea Area.

This suggestion rests on slender evidence, and it represents only one of many methods of speciation in the group; but if it can be soundly established, it may help to explain the great divergence of polychæte families coupled with the almost world-wide distribution of many of them. Further, the subject offers interesting possibilities in the explanation of the evolution of some of the major invertebrate groups.

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and
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Sept. 27.

[1] McIntosh, W. C., "The British Marine Annelids", **2**, pt. 2, 383 (Ray Society, London, 1873–1923).
[2] Clark, R. B., *Proc. Roy. Soc. Edin.* (In the press).
[3] Barnes, H., *Nature*, **166**, 447 (1950).
[4] Thorson, G., *Medd. Komm. Danm. Fisk- og Havunders.*, ser. Plankton, **4**, 1 (1946).

Recovery of Electron Microscope Grids

FILMED electron microscope grids, once exposed to the electron beam, cannot be cleaned by any of the usual solvents. The nitrocellulose is altered so as to become insoluble in amyl acetate even after prolonged boiling, and examination of the grid in the electron microscope still shows the tell-tale scraps of film in the corners of the squares.

It has been found in this Department that flaming the grids removes all trace of the film or specimen. The procedure is similar to the flaming of platinum loops in bacteriological laboratories, with the difference in the case of the copper grids that the exposure to the flame must be very short, otherwise the metal of the grid is oxidized away. This can be done in two ways: passing the grid fairly rapidly through the main body of the flame, or fairly slowly through the tip of the flame. Either method works quite

Corner of copper grid, cleaned by flaming. (× 2,700)

satisfactorily; it is necessary to find the correct exposure by trial and error.

While the copper grids must be handled carefully and given the minimum exposure compatible with complete clearing, the woven nickel grids are very robust and can be given quite long exposures without affecting their strength. In tests in this laboratory, such a grid selected at random from a box was held at white heat for two seconds and cooled ten times without showing signs of deterioration other than tarnishing of the surface.

The accompanying photograph shows the corner of a copper grid cleaned by this method.

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Jan. 31.

Influence of Structure on the Plastic Flow of Steel above the A_3-Point

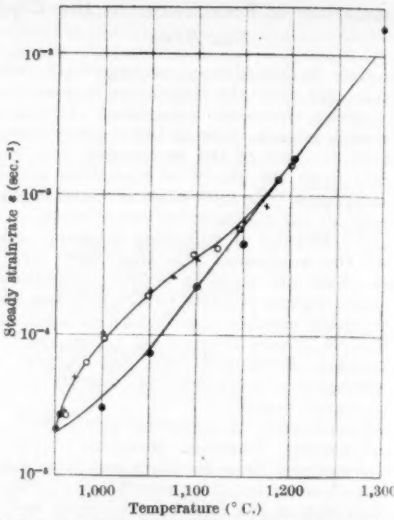
In connexion with the work done on the plastic flow of steel above the A_3-point, a detailed account of which will be published elsewhere, it was desirable to determine whether the relationship between the temperature and flow-rate at a given stress, hitherto determined by means of a series of experiments, each involving the flow of a separate specimen at a different temperature, could not be deduced without appreciable error from a single experiment in which flow took place under conditions of rising temperature. This possibility was investigated in two similar experiments. In each the specimen was first annealed *in vacuo* at 950° for approximately twenty minutes *in situ*. Then it was allowed to flow at that temperature under a constant tensile stress until the steady flow had definitely established itself, when the temperature was raised at an approximately constant rate from 950° to 1,250° C. in twelve minutes. The extension, time and temperature were recorded simultaneously. The natural strain-rates at temperatures in this range, which were deduced from these readings, were found to be considerably higher (upper curve) over most of the range than the corresponding values obtained under conditions of constant temperature.

In the flow at constant temperature[1], specimens were annealed as before, prior to the application of the stress, each, however, at the same temperature at which it was ultimately allowed to flow. Within the stress and temperature regions 190–450 kgm./cm.², 950–1,300° C. respectively, the natural tensile strain-rate $\dot{\epsilon}$ of the steady, quasi-viscous flow of plain 0·2 per cent carbon steel flowing under constant stress *in vacuo* was thus found to be given, within the limits of experimental error, by

$$\dot{\epsilon} = A.T.\exp(-H/kT).\sinh(q\sigma/kT),$$

where $A = 6{\cdot}6 \times 10^{-3}$ sec.$^{-1}$/° C., $H/k = 36{\cdot}8 \times 10^3$ °C., $q/k = 22{\cdot}0$ cm.²/°C. kgm., σ being expressed in kgm./cm.² and $\dot{\epsilon}$ in sec.$^{-1}$. Experimental points, obtained with specimens flowing under a stress of 197 kgm./cm.², denoted by black dots, together with the (lower) curve derived from the above relation, are shown in the graph.

The conclusion is reached that, within the given ranges of the variables, the influence of the initial state of the metal on the flow precludes the possibility of a simple derivation of steady strain-rates of specimens annealed at the flow-temperature by means of data obtained from the flow under conditions of varying temperature. The origin of the discrepancies presumably lies in the non-attainment at all temperatures in the range, in specimens flowing under conditions of varying temperature, of a characteristic grain-size, such as is attained in individual specimens annealed at the temperature of flow[2,3]. However, the observed ultimate coalescence of both curves indicates that the second method might fulfil its intended purpose outside the range of variables so far investigated.



Plastic flow of 0·2 per cent carbon steel at constant stress of 197 kgm./cm.²: (1) ●—●—, flow at constant temperature; (2) ×—×—, flow at rising temperature; (3) ○—○—, repeat of (2)

P. Feltham

Physics Laboratories,
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Battersea,
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Jan. 1.

[1] Feltham, P., *Metal Treatment* (Oct. 1951).
[2] Cleaves, H. E., and Hiegel, J. M., *J. of Research*, **28**, 643 (1942).
[3] Shushpanov, I. L., *Metallurg.*, **12**, 31 (1937).

Multiple Monochromators

In a recent communication, Rochester and Martin[1] have commented on my note[2] describing the construction of multiple monochromators, and claim that two similar ideas have been suggested previously. One of these suggestions, which is merely an extension of the Littrow principle, had not been published; the other[3], so far as I am aware, has not been put into practice, and it remains to be proved that the method is practicable. Neither of these proposed methods can be extended for the construction of other than double monochromators. The same limitation applies also to the modification of my method proposed by Rochester and Martin. Comments on this will be reserved until they have tested this modification and published the results obtained.

Rochester and Martin implied that I merely "suggested" a method. However, a specific method which had already been put into practice was described, and its merits were illustrated by results which had been obtained.

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Commonwealth Scientific and
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Melbourne.

[1] Rochester, G. C. O., and Martin, A. E., *Nature*, **168**, 785 (1951).
[2] Walsh, A., *Nature*, **167**, 810 (1951).
[3] *Perkin–Elmer Instrument News*, **1**, No. 4, 3 (1950).

A Quadruple Monochromator

IN previous communications[1-3], the principle of a method for converting a single monochromator into a multiple monochromator and the application of this principle to the construction of double monochromators were described. An infra-red spectrometer constructed on this principle showed a considerable improvement over a single monochromator. A quadruple monochromator has now been constructed on the same principle, and our experience indicates that the construction of higher-order monochromators will not be unduly difficult.

In Fig. 1, S_1 is the entrance, and S_2 the exit, slit of a typical monochromator. When used in the conventional manner, radiation passing through S_1 falls on the dispersing system and radiation of wave-length λ_1 passes through the exit slit S_2. By placing two mirrors M_3M_4 at right-angles to each other and with their apex on S_1, radiation of another wave-length λ_2 falls on M_3M_4, and returns once more through the dispersing system before passing through the exit slit S_2. Similarly, radiation of wave-length λ_n will undergo n dispersions before passing through the exit slit. Thus, for one position of the dispersing system, radiation of several different wave-lengths falls on the exit slit. Suppose it is desired to isolate radiation of a given order, for example, the fourth. Referring to Fig. 1, this is achieved by arranging a small chopper in such a manner that it interrupts, at a given frequency, radiation of the fourth order at the position where it first strikes the mirror M_3, that is, at A. It is simple to ensure that radiation

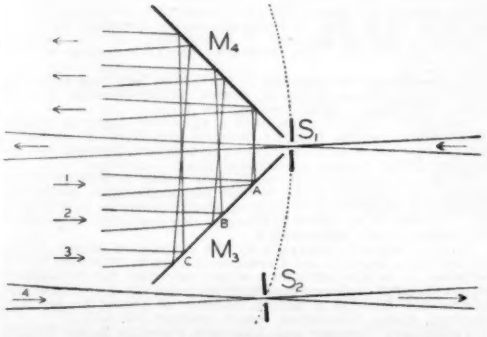

Fig. 1. Diagram illustrating method for converting a single to a quadruple monochromator

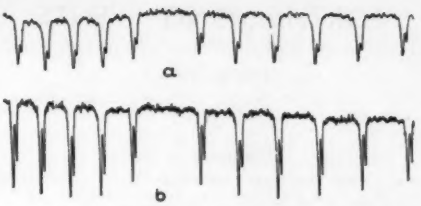

Fig. 2. 3·5-μ band of hydrogen chloride obtained with (*a*) a double and (*b*) a quadruple monochromator. Lithium fluoride prism

of any other order cannot be chopped and pass through the exit slit. The curvature of the slits of the conventional monochromator must be modified to accommodate the increased image-curvature of the fourth order. By passing the signal from the detector to an amplifier tuned to the same frequency as the chopper, only the fourth-order radiation produces an output signal.

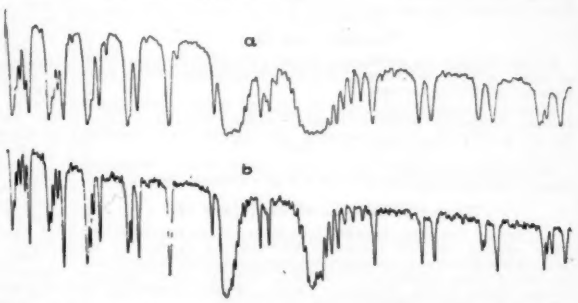

Fig. 3. 10-μ band of ammonia obtained with (*a*) a double and (*b*) a quadruple monochromator. Sodium chloride prism

A Perkin–Elmer infra-red spectrometer (Model 12*C*) has been converted to a quadruple monochromator by the method described above. Typical spectra are shown in Figs. 2 and 3. Fig. 2 shows the 3·46-μ band of hydrogen chloride taken on the double and quadruple monochromators using a lithium fluoride prism. The isotope lines (separation 2·0 cm.$^{-1}$) cannot be resolved with the single monochromator. Fig. 3 shows the 10-μ band of ammonia obtained with the double and quadruple monochromators using a sodium chloride prism. Spectra have also been obtained using calcium fluoride and potassium bromide prisms, and resolutions obtained of the order of 0·25 cm.$^{-1}$ (6-μ water-vapour band) and 0·8 cm.$^{-1}$ (at 520 cm.$^{-1}$ in the rotational water-vapour band) respectively. As in the double monochromator, the amount of scattered radiation is too small to be detected.

A fuller discussion of the design and performance of the quadruple monochromator will be published shortly.

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Dec. 5.

[1] Walsh, A., *Nature*, **167**, 810 (1951).
[2,3] Walsh, A., *J. Opt. Soc. Amer.* [Feb. 1952].

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, June 9

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. H. F. P. Herdman: "The Voyage of *Discovery II*, 1950–51".

Tuesday, June 10

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Mr. Michael Banton: "The Social Groupings of Some West African Migrants".

Wednesday, June 11

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "The Incidence of *Mycobacterium tuberculosis* in various Types of Raw and Heated Milk with Observations on the Control of the HTST Process" (to be opened by Dr. J. G. Davis).

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Wellcome Research Institution (at 189 Euston Road, London, N.W.1), at 5.30 p.m.—First showing of film of the New Sign Language devised by Sir Richard Paget.*

British Psychological Society, Social Psychology Section (in the Department of Psychology, University College, Gower Street, London, W.C.1), at 8.15 p.m.—Dr. Adam C. T. W. Curle: "Some Effects of Social Change".

Thursday, June 12

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. H. Jeffreys, F.R.S.: "The Origin of the Solar System" (Bakerian Lecture).

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. W. K. Hayman: "An Inequality with Applications to Function Theory".

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Thursday, June 12—Friday, June 13

Society of Chemical Industry, Chemical Engineering Group (joint meeting with the Chemical Engineering Section of the Koninklijk Instituut van Ingenieurs and the Chemical Engineering Group of the Netherlands Chemical Society, at the Connaught Rooms, Queen Street, Kingsway, London, W.C.2).—Conference on "Fluidization Technology".

Friday, June 13

British Society of Rheology (at the Institute of Physics, 47 Belgrave Square, London, S.W.1), at 2.30 p.m.—Discussion on "Tack and Adhesion".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Worker in the Department of Psychology, to take part in experimental studies of group behaviour—The Secretary, University College, Gower Street, London, W.C.1 (June 13).

Assistant Lecturer in Chemistry, to specialize in inorganic and analytical chemistry up to Final B.Sc. (Special) standard—The Principal, Brighton Technical College, Brighton 7 (June 14).

Lecturer (with an honours degree in chemistry, together with experience in industry, teaching and/or research) in Chemistry—The Principal, Wigan and District Mining and Technical College, Wigan (June 14).

Lecturer (with a good honours degree in chemistry, with research and/or industrial experience, and prepared to teach the subject to Special Honours B.Sc. standard) in Physical and Inorganic Chemistry at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (June 14).

Biologist (Field Zoologist) to co-operate in the control of animal trypanosomiasis in the Southern Sudan by securing scientific information about game animals, and later assisting in the application of scientific principles for the control of their movements—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Biologist (Field Zoologist)' (June 15).

Assistant Lecturer or Lecturer in Geology—The Registrar, University College, Singleton Park, Swansea (June 16).

Assistant in the Department of Physics in University College, Dundee—The Secretary, The University, St. Andrews (June 16).

Assistant Lecturer in Mechanical Engineering—The Registrar, College of Technology, Manchester 1 (June 16).

Assistant mainly for Field Survey and experimental work on Physiographical and Coastal Research—The Establishment Officer, Nature Conservancy, 91 Victoria Street, London, S.W.1 (June 18).

University Lecturer in Statistics, and a University Lecturer in Economics—The Secretary of the Appointments Committee, Marshall Library, Downing Street, Cambridge (June 18).

Lecturers in Science and Engineering, and Lecturers in Mathematics, at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4143/52 (June 19).

Research Assistant in Radiochemistry—The Secretary, The University, 38 North Bailey, Durham (June 21).

Chemist (Principal Scientific Officer or Senior Scientific Officer grade) with special knowledge and research experience in soil chemistry and/or plant chemistry—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (June 23).

Lecturer and/or Assistant (Grade B) in Geology up to B.Sc. standard—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 23).

Plant Physiologist (Principal Scientific Officer or Senior Scientific Officer grade)—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (June 23).

Assistant Mycologist at the Long Ashton Research Station—The Registrar, The University, Bristol 8 (June 28).

Lecturer (graduate in agriculture with qualifications in agricultural engineering) in Farm Mechanization—The Registrar, The University, Reading (June 30).

Lecturer or Senior Lecturer in Pharmacology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

Nuffield Studentships and Fellowships for experimental and theoretical research in nuclear and elementary physics—The Professor of Natural Philosophy, The University, Glasgow (June 30).

University Lecturers or University Assistant Lecturers in the Faculty of Mathematics—Dr. R. A. Lyttleton, St. John's College, Cambridge (June 30).

Lecturer (with an honours degree in electrical engineering or physics, and industrial or research experience), a Lecturer (with an honours degree in civil or mechanical engineering, and industrial or research experience), and an Assistant (with an honours degree in civil or mechanical engineering, and industrial or research experience), in the Department of Engineering—The Secretary, The University, Edinburgh (July 1).

Lecturer in Veterinary Medicine (Farm Animals)—The Registrar, The University, Liverpool (July 7).

Senior Lecturers or Lecturers in Botany, Chemistry, and Zoology (with special reference to marine zoology), at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 12).

Assistant Director of the National Chemical Laboratory, Poona—The Scientific Adviser, India House, Aldwych, London, W.C.2 (New Delhi, July 15).

Physicists (with Ph.D. degree) interested in low temperatures, solid state, and spectroscopy, in the Department of Physics, University of British Columbia, Vancouver—The Head of the Department of Physics, University of British Columbia, B.C. House, 1–3 Regent Street, London, S.W.1 (July 15).

Senior Lecturer in Ore Dressing at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5, Gordon Square, London, W.C.1 (July 31).

Senior Lecturer in Gas and Fuel Technology in the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 1).

Assistant Lecturer (with an honours degree in chemistry, and able to teach one branch of chemistry up to B.Sc. Special Chemistry Degree standard) in the School of Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Chemist, for development work on shoe materials, including plastics, rubbers, adhesives and leather—The Director of Research, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

Demonstrator (with a good honours degree in botany or agricultural botany) in Botany in the Department of Biological Sciences—The Registrar, Wye College, Wye, Ashford, Kent.

Junior Mining Geologists to the Government of Iraq, to undertake survey work into the mineral deposits of Northern Iraq with a view to their commercial exploitation—The Ministry of Labour and National Service, Technical and Scientific Register (A.S.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/ME/217/51.

Junior Research Officer (with honours degree in chemistry, or equivalent) for analytical work, including development and application of analytical methods—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Lecturer (woman) in Dairy Bacteriology—The Principal, Studley College, Studley, Warwickshire.

Lecturers and Assistant Lecturers in Pharmaceutics, Pharmacognosy, Pharmaceutical Chemistry, Physiology/Pharmacology, in the School of Pharmacy, and an Assistant Lecturer (with a degree in chemistry or biochemistry) in the Scottish School of Bakery—The Secretary, Royal Technical College, Glasgow.

Postgraduate Studentships in the field of locust research—The Director, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7.

Regional Trials Officer (with a University degree or diploma in agriculture and/or biology; previous experience of conducting field trials would be an advantage)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Scientific Officer (with an honours degree in zoology) in the Edinburgh laboratory of the Scottish Marine Biological Association, to join a team of biologists studying plankton ecology in relation to the fisheries—The Officer-in-Charge, Oceanographic Laboratory, 78 Craighall Road, Edinburgh 5.

Senior Chemical Engineer by the Division of Atomic Energy (Production), Research and Development Branch, Windscale Works, Sellafield, to be responsible for a section concerned with development of new chemical processes, including the design and operation of pilot plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 325.

Veterinary Officers and Research Officers in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 130–173/52.